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ILLUSTRATED JOURNAL OF SCIENCE

VOLUME CXIV

JULY, 1924, to DECEMBER, 1924

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

London
MACMILLAN AND CO., LIMITED
NEW YORK: MACMILLAN COMPANY

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Supplements should be bound with the numbers in which they appear.

Printed in Great Britain by R. & R. Clark, Limited, *Edinburgh.*

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

SATURDAY, JULY 5, 1924.

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The Imperial Institute Bill.

A GOVERNMENT Bill to effect the reorganisation of the Imperial Institute has been introduced into the House of Lords by Lord Arnold and there passed its second reading. This Bill will be welcomed, as it should help the development of that Institute to a position worthy of the group of museums and scientific institutions at South Kensington. The Colonial Office Committee of Enquiry into the Imperial Institute in 1923 recommended the abolition of its galleries, the limitation of the work of its laboratories to preliminary investigations of raw materials, and the reduction of the Institute to a clerical bureau. This scheme was approved by the Imperial Economic Conference, some members of which were unacquainted with the facts, as one of them has since stated. If the majority report of the Colonial Office Committee had been promptly carried into effect, the Imperial Institute collections would have been scattered and the galleries occupied by a War Museum, which, however desirable, would have been out of place in South Kensington on a site allotted to the development of the industrial arts and science by the Commissioners for the Exhibition of 1851. The majority report of the Committee was opposed by a strong minority, and has since been widely condemned.

The Bill, in agreement with the minority report, is based on the retention of the Imperial Institute galleries and the amalgamation of the Mineral Resources Bureau with the Mineral Department of the Institute. The Bill proposes the transfer of the management of the Institute from the Colonial Office to the Department of Overseas Trade, which is a branch of the Board of Trade, and the establishment of a new Board of Governors consisting of representatives of the Dominion of Canada, Australia, New Zealand, South Africa, the Irish Free State, Newfoundland, and India,

and representatives of the Treasury, the Board of Trade, the Colonial Office, the Ministry of Agriculture and Fisheries, the Department of Overseas Trade, and the Department of Scientific and Industrial Research, and not more than ten scientific and commercial representatives, including one from the Royal Society and not less than three Governors of the Mineral Resources Bureau.

The property would be vested in six Trustees, all of whom would be members of the Government. As the Imperial Institute was erected and endowed largely by public subscription and its main service would be to the smaller colonies, it is desirable that some of the Trustees should be unofficial, and one of them should represent directly the Empire overseas. More confidence in this Board of Trustees would be felt if only three of them were members of the Government, and the other three included a representative of the Dominions, the president of the Association of the British Chambers of Commerce, and some such authority as the Governor of the Bank of England or the president of the Institution of Mining and Metallurgy.

The Board of Governors would act through a Managing Committee which would be aided by various advisory councils or committees, including one on minerals, and would be associated with a Laboratory Committee, including representatives of the Department of Scientific and Industrial Research and of the Royal Society.

This Bill renders possible the development of the Imperial Institute as a great museum and research institution for the investigation of the natural resources of the British Empire overseas. The reconstituted Institute might develop into an organisation capable of giving important help in the investigation of the economic geology and mineral resources of the Empire outside Great Britain. The Bill is, however, unsatisfactory in two respects in which the terminology of the abandoned majority report has passed into the Act. That report recommended the appointment of a Laboratory Committee, the functions of which would render the Institute laboratories futile. The Laboratory Committee, according to the resolution of the Imperial Economic Conference, was proposed "to ensure that the reconstituted Imperial Institute may in future undertake in its laboratories only preliminary investigations of raw materials for the purpose of ascertaining their possible commercial value. . . ." If any more extensive research or investigation be required, it would be the duty of the Laboratory Committee to see that the material were sent to some other authority in Great Britain or "elsewhere within the Empire."

This proposal would, if carried into effect, seriously lessen the usefulness of the Institute. Many of the most interesting materials it might expect to receive would be submitted in confidence, which would not be felt if the material were to be distributed to University or public laboratories for investigation. The various Departments of the Institute would doubtless include experts in some branches of its work, and they would sometimes have to send on material for investigation to people less competent to deal with it than themselves.

The scheme would probably also involve risk of trouble between the several committees of the Institute. The Managing Committee and the Mineral Committee would naturally desire to escape from the restriction to preliminary work, though ready to seek the co-operation of authorities who might be specially competent to deal with special materials or problems. The Managing and the Mineral Committees might therefore be in frequent friction with the Laboratory Committee, the duty of which would be to see that the other committees and the Institute staff committed nothing beyond an elementary commercial examination. The clause in the schedule enumerating the purposes of the Institute "To conduct preliminary investigations of raw materials and, when it may be deemed advisable, to arrange for more detailed investigation by appropriate scientific or technical institutions," therefore, might well be amended by omission of the word "preliminary" and the alteration of "more detailed" into "further" investigation.

The main discussion hitherto has been over the galleries, the great educational value of which has been frequently pointed out in NATURE. The new Bill empowers the governing body to maintain galleries for the exhibition of Empire products. If the Bill be passed as now worded, some future official might maintain that collections of commercial samples in the Dominion offices in different parts of London would satisfy this clause, and this Bill might be used to give effect to the very policy which it is understood that the Government at present in office has abandoned.

The schedule stating the purposes of the Imperial Institute does not even refer to the Institute galleries. The only clause dealing with collections states that the Institute is "to organise, so far as practicable, exhibitions of Empire products." This clause is quite inadequate as a statement of the duties of the Institute in connexion with its public exhibition galleries. It implies that all the Institute should arrange is exhibitions of commercial samples, which, as the Colonial Office Committee recommended, might be peripatetic.

The clause should be amended to state definitely that the Institute should retain its galleries at South Kensington and maintain in them exhibitions of the products of the Empire, so displayed as to demonstrate their nature and uses, and to illustrate adequately the geographical conditions and material resources of the British Empire.

A few amendments are therefore desirable to prevent ambiguity. Without these changes, there is the risk that the Act will, in effect, be used to return to the recommendations of the majority report of the Colonial Office Committee of Enquiry, and thus to prevent the Imperial Institute from fulfilling the important functions proposed for it by its far-seeing and generous founders.

The New Astronomy.

The Depths of the Universe. By George Ellery Hale. Pp. xv+98. (New York and London: Charles Scribner's Sons, 1924.) 7*s.* 6*d.* net.

ASTRONOMY is a subject which, in spite of the delicate refinement of its observations and the severe technicality of its mathematical processes, yields results which can be fairly apprehended by the general educated public,—results moreover which, though apparently far removed from humanity, yet invariably arouse a human interest. There was a time when it appeared to be a completed, so to speak, perfected science, in which little of a revolutionary character was to be expected. But modern discoveries in physics have changed all that; and discoveries are yearly being made which are likely to enlarge our ideas about the constitution of the heavens in a striking and revolutionary manner.

Part of this progress is due to the enthusiastic workers, and the great resources provided for them, on the other side of the Atlantic; where lavish provision has been made for experimental resources, where sufficient mathematical skill is available for devising methods and interpreting results, and where the clearness of the air on mountain-tops has been utilised after the enterprising manner characteristic of the American nation.

Among the workers in novel directions the name of George Ellery Hale is held in honour throughout the civilised world; and the whole world hopes for his restoration to health, so that he may continue to infect his co-workers with enthusiasm, and that he may have the joy of continuing the utilisation of the magnificent Observatory and laboratories on the top of Mount Wilson in California. Meanwhile he has been giving us the benefit of his powers of exposition in articles and discourses, some of which are being collected in small and illustrated books, one called "The New Heavens," and another, which has just been published, entitled "The Depths of the Universe." The main branches of the subject dealt with in this little volume are three in number. The first relates to the stars and star clusters, with some account of the remarkable and novel principles by which spectroscopic determination of excessive and otherwise hopelessly immeasurable distances can be made. The second relates to the nebulæ, and especially to the dark nebulæ discovered by the late Edward Emerson Barnard, of the Yerkes Observatory, whose lamented death has so recently occurred, and to whom the author pays an affectionate and admiring tribute. While the third chapter in the book gives further details about the author's own great discovery about the magnetic condition of the sun and its spots, a subject begun to be expounded in one of the chapters of "The New Heavens," and now carried to a further stage.

The treatment throughout is of a popular character, and all recent advances are linked on to the history of the past. Thus in the first chapter, which is specially on "The Depths of the Universe," Prof. Hale begins with Galileo and the first telescope, and carries the history rapidly forward, through Herschel, to the determination of stellar and globular-cluster distances by Dr. Harlow Shapley, of Harvard.

The main theme of the first chapter is the size and shape of our stellar cosmos, familiar to all as "the Milky Way," which must be of unexpectedly vast extent if the immensely distant globular clusters form any part of it. Outstanding questions about the spiral nebulæ are not dealt with; but many details are given about other objects, and especially the dark nebulæ emphasised by Barnard. Some of them are regarded as immense clouds of dust driven away by the pressure of light, but held together, even in diffuse form, by their own gravitation. It is suggested that many of the nebulæ are only luminous because they reflect, or fluoresce in, the light of luminous stars in their neighbourhood. This seems specially to apply to the great nebula in Orion. But the globular star clusters are of a different order, perhaps more analogous to the constellation of Orion itself, the great cluster or crowded and enormous constellation in Hercules being apparently at a distance of 36,000 light-years.

Incidentally I would here express a hope that the light-year, as a unit of stellar distance, may be generally employed instead of the less satisfactory parsec, as a cosmic measure. Distances can very properly be expressed in terms of speed and time: that is indeed the fundamental way of measuring them, and far superior to anything dependent on the copying of an arbitrary unit such as a yard or a metre. Parallax,

dependent on the length between earth and sun, is absurdly incompetent to express enormous distances: the period of earth's revolution combined with the speed of light is better. It seems impracticable to get away altogether from the earth, in devising a cosmic unit, but the periods of the earth's rotation and revolution are universal terrestrial units of time; while as to the velocity of light, it appears to be about the only absolute thing we know.

To return from this brief digression. In order to emphasise the enormous number of stars now accessible to photography, Prof. Hale gives an interesting series of photographs, with different exposures, of a small region in Auriga near a third magnitude star. The first exposure is long enough to show stars down to the ninth magnitude, but none are visible, only the big one. The second exposure would show twelfth magnitude stars, and there are now five or six on the plate. A further exposure, long enough to bring out those of the fifteenth magnitude, shows something like fifty in all. Exposing long enough for seventeenth magnitude stars, more than two hundred appear; and when stars of the eighteenth magnitude are allowed time enough to impress the plate, the field is crowded with a number like four hundred.

The chapter on sun-spots begins with ancient observations, and continues, through the discovery of Faraday of the rotatory effect of magnetism on light, to the supplementary great discovery of Zeeman; and so on to its quite recent application by Prof. Hale to ascertain the nature of the hydrogen vortices in the upper layers of the sun, which appear to be more or less closely associated with the deeper-seated sun-spots below. Every one now knows that the lower regions of a sun-spot were proved to be powerfully magnetised by Hale's discovery of the Zeeman effect in the light emitted by them. This discovery has now been extended into most interesting detail, by the splendid power of the 150-ft. tower telescope erected on the top of Mount Wilson, with a spectroscope 75 ft. long sunk in a well below it. This telescope forms an image of the sun 16½ in. in diameter. A small sun-spot can be focussed on the slit of the 75-ft. spectroscope, so as to fall on a Rowland grating at the bottom of the well; and, though the slit is only three thousandths of an inch wide, the light passing through it is returned as a long spectrum extending 40 ft. from red to violet—a spectrum of the second order, on photographs of which observations can be made, with complete polarimetric proof that the interior of a spot produces precisely similar effects to those of an ordinary powerful longitudinal magnetic field.

The result has been to confirm the importance of the eleven-year solar period, and to show that it is only half the real period, when not merely the appearance of spots but their magnetisation is taken into account. Sun-spots are known to begin far from the solar equator during a minimum, and gradually to form nearer the equator. It would be simple if we could say that all those in the northern hemisphere of the sun are magnetised one way, and all those in the southern hemisphere magnetised the other way, and that then in the next sun-spot period these directions were reversed. That is not true, though something like it is true. It is not true because sun-spots do not occur singly. They occur for the most part in pairs, the two components of each pair not being necessarily equally well marked. They might be likened provisionally to the two opposite whirls we see when a teaspoon is drawn across a cup of tea; those two whirls are united by a semicircular vortex below. It may be so in the sun, though that is not yet clear. Allowing the analogy, however, the teaspoon must be drawn one way in the northern hemisphere and the opposite way in the southern during one eleven-year period; but in the next eleven-year period these directions must be reversed, giving twenty-two years for the time of the whole cycle of changes.

Moreover, by their magnetic properties, Hale found it possible to discover invisible or submerged sun-spots. They are all deep-seated disturbances, far below the photosphere; and it is only when a hydrogen whirl in the upper regions coincides with the electronic whirl below, that they burst out as it were and become visible. A great slowly alternating magnetic disturbance is going on in the body of the sun, of a quite unknown character, and with a twenty-two year period. These great electrical whirls must have a profound meaning, not yet dissected out. We are so dependent on the sun for everything, that they may have an unexpected influence on terrestrial phenomena and earth life. Meanwhile, we only know of them—at least until quite recently—by the manifestation we call sun-spots, when whirls happen to extend into the upper regions of the solar atmosphere and so break through.

Discovery is still going on; and it is to be hoped that Prof. Hale and his co-workers may long continue to elucidate this portentous phenomenon, which has proved itself so much more law-abiding than anything in our terrestrial weather and storms appear to be. There are some analogies: there may even be some connexion, but at present we can only say that whatever may be the truth about cyclones in the earth's atmosphere, they certainly exist on a huge scale in the solar atmosphere, or solar substance—for the whole sun may be obedient to the laws of gases at that high temperature—and that probably much more remains to be discovered about both.

OLIVER LODGE.

Modern Chemistry.

Chemistry in the Twentieth Century: an Account of the Achievement and the Present State of Knowledge in Chemical Science. Prepared under the guidance of a Committee representing the Scientific Societies, with Dr. E. F. Armstrong as Chairman and Editor. Pp. 281. (London: Ernest Benn, Ltd., 1924.) 15*s.* net.

IT was a very happy thought which prompted the preparation of this impressive work under the guidance of a committee representing the scientific societies, with Dr. E. F. Armstrong as chairman and editor. No one even remotely interested in the achievements of chemical science who visits the Chemical Hall at the British Empire Exhibition can fail to be profoundly impressed by the display of chemical products which he sees there, but he will not perhaps so easily realise the important part which British scientific workers have played in building up the knowledge which rendered that display possible. To make the achievements of British chemists clear to all the world is the purpose of the book under review; and the purpose is realised most excellently in this series of monographs written by distinguished men of science and preceded by an introduction from the pen of the editor. After reading through the 280 pages or so of which the volume consists, one has a feeling of pride in the work which British chemists and men of science have accomplished.

In a series of two dozen articles there is told, in a language which all who have a moderate acquaintance with chemistry can understand, the story of the growth of chemical science during the past quarter of a century, as promoted more especially by the labours of British chemists. In his general introduction, Dr. E. F. Armstrong gives an excellently composed survey of the domain as a whole, and we get here the kernel of the succeeding specialised articles. The opening sections of the work deal with the physical basis of matter: the atom, the molecule, the ion (by Prof. I. Masson); the structure of the atom (Dr. E. N. da C. Andrade); crystallography (Mr. T. V. Barker and Sir Henry Miers); and X-ray analysis of crystals (Sir William Bragg). These articles give a very complete survey of the whole domain of atomics, sub-atomics, and atomic arrangement in crystals, and will convey an adequate knowledge of these subjects to those whose main interests lie in other directions.

The story of the rare gases of the atmosphere is told delightfully by Dr. Travers, who does not fail to point out the practical applications of argon and helium and neon, a matter in which the layman is always specially interested.

The almost autobiographical sketch, "Milestones in Organic Chemistry," by Prof. H. E. Armstrong, one would gladly have seen expanded to greater length. It is a piece of history which all younger students of chemistry should read and ponder. The reviewer feels that it should have been placed before, not after, the article on the chemistry of the carbon compounds by Prof. J. F. Thorpe, in which the author discusses with amazing skill almost the whole realm of organic chemistry. Stereochemistry might perhaps have received rather more space.

The "Chemistry of Colloids" (Dr. W. Clayton), "Catalysis" (Dr. T. P. Hilditch), and "Fats and Oils" (Mr. J. Allan), are brief but clearly written, and will be read with pleasure. The story of one of the most notable British contributions to organic chemistry, the work of the St. Andrews school on carbohydrates, is told, as one would wish it told, by the director of the investigations, Principal Irvine. The work of Scottish chemists also finds a prominent place in the "syntheses in the terpene series," and one regrets that no room was found for an article on stereochemistry, to the development of which past and present workers in University College, Dundee, have very largely contributed.

"Cellulose" (Mr. C. F. Cross), "Colour in Nature" (Mr. R. Furness), "Coal-tar Colours" (Mr. E. A. Bearder), all deal with sections of chemistry which have been largely developed by British chemists, and the enormous growth of the cellulose industries, production of viscose silk, etc., is one of the achievements of applied chemistry of which British chemists may be proud.

How great has been the progress in biochemistry and in branches related thereto, is well seen from the interesting series of articles by Drs. F. L. Pyman and T. A. Henry ("The Alkaloids"), by Dr. R. H. A. Plimmer ("The Nitrogenous Constituents of the Living Cell"), by Dr. A. Harden ("Biochemistry and Fermentation"), and by Sir John Russell and Mr. H. J. Page ("The Chemistry of the Soil and of Crop Production").

The development of the production and utilisation of alloys and of pottery and refractories is described by Prof. C. H. Desch and by Mr. Joseph Burton. Dr. H. F. Coward contributes an interesting article on "Flame, Fuel, and Explosion," in the study of which Great Britain holds a foremost place; and Sir Robert Robertson writes, as few others could write, on "Explosives." The achievements of British chemists since 1914 in this important section of chemistry are perhaps insufficiently known and insufficiently appreciated. "The Chemistry of Photography," by Sir William Pope and Mr. W. Clark, fittingly concludes the volume. The production of plates sensitive to light of all colours and capable of giving a correct

rendering of different colour tones is a great advance due to chemists, and in the production of the necessary dyes the Cambridge chemistry school occupies a prominent position.

For this great record of achievement all British chemists, at least, will be very grateful. For some reasons, perhaps, one might have preferred a more homogeneous composition from a single pen; but in the time available such a production would have been impossible. On the other hand, compensation is found in the fact that impressiveness is added to the tale, and a sense of the magnitude of the contribution of British workers to chemical science is given by the rapid change of subject and of literary style. This book should itself occupy a prominent position in the Chemical Hall at Wembley. ALEX. FINDLAY.

The Unity of Life.

Life: a Book for Elementary Students. By Sir Arthur E. Shipley. Pp. xvi+204. (Cambridge: At the University Press, 1923.) 6*s.* net.

SIR ARTHUR SHIPLEY'S little book is of an unusual type. "A year ago," he says in his preface, "the University Press asked me to write a book that would make students of elementary Biology think." Perhaps this is putting the matter a little strongly: it is scarcely just to suggest that students of elementary biology have not previously used their brains.

In his book Sir Arthur has tried to get away from the type system, and "to emphasise the unity of Life and the interrelation of living organisms." But he has still another purpose. "Finally, I venture to hope that this book will be not without interest to the public that is not preparing for examinations, and thank heaven that public is still in the great majority!"

What we lack in Great Britain is not school text-books of biology. On the contrary, there are too many, and they are usually too large, too well-organised and too informative. The great desideratum is a school *reader*—a book that might really interest a reasonable proportion of boys. "Life," if not the ideal book for the purpose, is at least of the desired type.

As the author's friends would expect, it is not only lucidly but engagingly written. You may tell a schoolboy a dozen times the percentage of water in the human body, and ten to one he will forget it. But when he reads "Even the Archbishop of Canterbury comprises 59 per cent. of water," he may remember. Or again, we are all taught that plants differ from animals in obtaining their nutriment from inorganic compounds. But the fact becomes vivid and fraught with consequences when we find it put as Sir Arthur puts it: "Their food comes to them as the roast geese in Heine's description of Heaven perpetually flew up to the angels offering them tureens of delicious soup;" but "the pleasure of the chase is denied them. Their food must be intolerably monotonous and extremely insipid. . . . Yet one hears no complaint."

The description of what a patch of grouse-moor would look like if magnified a hundred times is alone almost worth the price of the book. Admirable too is the dictum, "Fleas do not jump anything like the height or length that you think they do when you are trying to catch them." As a finale, we cannot refrain from quoting from the characteristic section on appetite. "Hunger undoubtedly induces people to eat food which a well satisfied man would not care to tackle. On the other hand, elaborate sauces and good cooking will often tempt a jaded appetite to put forth new efforts." Then we are told of the gastronomic preferences of Sydney Smith, Disraeli, Charles Lamb, and Dr. Johnson, and are hoping for more, when our author's conscience pricks him and he ends, "But I must stop dealing with these literary appetites, and get on with the next chapter." But meanwhile in another chapter he has made an important pronouncement on the same subject: "Man is the only animal that cooks its food, but the distance between the rough cookery of the Australian native or an Abyssinian and that of a French chef is almost immeasurable. The higher branches of cookery are one of the chief arts in which men invariably rise superior to women. . . ."

The book is not, however, without its faults. There is too much illustrative detail; the beginner will often find it difficult to see the wood for the trees. Especially in the more recent fields of research, the author has not always shown himself very critical. There are various errors and omissions which should be rectified. *E.g.*, on p. 71, the only positive statement made about the economic status of wild birds is that "they do a great amount of destruction in our gardens and orchards, and our cornfields." This may be so, but if there is one established fact in economic ornithology it is that the net benefit due to birds is enormous. The statement (p. 5) that the ductless glands are "the cause of many obscure diseases" is surely a lapse of our author's usually lucid pen. Many free-living protozoa (including the familiar Paramecium) are easily visible to the naked eye, in spite of Sir Arthur's statement to the contrary (p. 18). If he had wished to be very up-to-date he might have put in a word of warning against overdoing the fat-soluble vitamin in adult life.

However, Sir Arthur's book deserves a place in the library of every school department of biology; the professional biologist will read it with pleasure, and the layman with both pleasure and profit. But the author might make the second edition even better than the first.

Our Bookshelf.

The Principles of Insect Control. By R. A. Wardle and P. Buckle. (Publications of the University of Manchester: Biological Series, No. 3.) Pp. xvi+295. (Manchester: University Press; London: Longmans, Green and Co., 1923.) 20*s.* net.

THE literature dealing with the various methods of controlling injurious insects has now assumed such vast proportions that it is almost beyond the capacity of the economic entomologist to keep abreast of it. The necessity has arisen for periodic stocktaking of this accumulated information in order that the situation may be reviewed as a whole. Messrs. Wardle and Buckle have rendered a very distinct service in providing an excellent résumé of the present-day position with regard to insect control. In undertaking this task they have had the difficulty of sifting a literature often contained in unfamiliar languages, and scattered through a heterogeneous series of scientific, technical, and practical publications—many of which are relatively inaccessible. The collation and arrangement of the extracted information also presents certain difficulties, particularly on account of the wide and disjointed range of subjects dealt with.

These troubles have been surmounted by the authors very successfully, and they have managed to produce a very readable and coherent book. Their method has been to divide the volume into four parts, comprising altogether sixteen chapters. Part I. is devoted to biological means of control, including host-resistance, effects of climatic factors, disease, predaceous and parasitic insects, and insectivorous birds. All these different subjects are, for the most part, adequately treated. Part II. is concerned with insecticides, and is the longest and best section of the book. Part III. deals with mechanical control, including cultural methods, restriction of spread, storage of crops, and baits and traps. The section devoted to cultural methods might perhaps have been longer in view of their importance, and more examples of such methods enumerated. Part IV. is devoted to a short discussion of legislative control, and the book concludes with an appendix on various types of insecticide machinery, together with a very good classified bibliography. In a few words, it may be said that the volume should appeal to economic entomologists, since it covers the whole field of a subject which has not been previously surveyed in so comprehensive a manner.

(1) *Foundations, Abutments, and Footings.* Pp. xiv+414. 20*s.* (2) *Structural Members and Connections.* Pp. xviii+611. 30*s.* (3) *Stresses in Framed Structures.* Pp. xiv+620. 25*s.* Compiled by a Staff of Specialists. Editors-in-chief, Prof. George A. Hool and Prof. W. S. Kinne. (Structural Engineers' Handbook Library.) (London: McGraw-Hill Publishing Co., Ltd., 1923.)

THE three volumes before us belong to a series of six, which is intended to provide a complete work of reference covering the design and construction of modern civil engineering structures. A large number of prominent American engineers have co-operated in the production, and the commendable plan has been followed of making each volume, so far as possible, complete in itself. (1) The volume on foundations is copiously illustrated with examples taken from practice, and deals with all the matters which require consideration, from the preliminary investigation of the soil to the completed foundation, and includes such special points as underpinning, waterproofing, etc. Practically all types of engineering foundations are included. (2) The volume on structural members and connexions opens with brief statements of the general theory, occupying the first 171 pages; the remainder of the volume is taken up with the design of steel, cast-iron, wooden, and reinforced concrete members. The student who has mastered the elementary work on materials will find much of interest in the earlier part of this volume. The part dealing with design is exceptionally good, and contains much matter which is usually either omitted or receives scant treatment in British text-books. (3) The volume on framed structures also opens with a section on the general theory, occupying 158 pages. This part is by no means copied from the second volume, and includes methods of treating moving loads. The remainder of the volume deals with roof and bridge trusses, portal bracing, deflexion, secondary stresses, statically indeterminate frames, high buildings, towers, etc. The slope-deflexion method is generally employed for the solution of statically indeterminate frames in this treatise. Taking all three volumes, the authors have succeeded in producing an extremely valuable work of reference which cannot fail to be of service to civil engineers.

Theory and Practice of Mine Ventilation: a Text-book for Students and a Book of Reference for Managers and Under-managers. By Thomas Bryson. Pp. viii+255. (London: E. Arnold and Co., 1924.) 8*s.* 6*d.* net.

MR. BRYSON is an experienced teacher of mining and is well known as a writer in mining technology. He has been at considerable pains to present his material in that order and manner which renders it most readily assimilable by the majority of his readers. The subject is undergoing re-solution; its treatment just now is difficult, and there is evidence that the author has not found it easy to balance between obsolescent dogma on one side and the quicksands of controversy on the other. The task is too Blondin-like to escape an occasional slip. We observe, for example, a repetition of the usual fallacy in reference to the origin of the "fuel cap," as the non-luminous mantle of a flame is inappropriately called. Nor do we agree with the neglect of the "dynamic water-gauge" at the expense of the "static gauge," especially as the former is required in determining the efficiency of fans. Again, the simpler and more precise form of Pitot tube made by the Cambridge and Paul Scientific Instrument Company is to be preferred to the type illustrated, and the simpler British alternative is more satisfactory than the hygrodeik.

It is to be doubted whether the inclusion of "ventilated" colliery plans without complete analysis can be of benefit. The author has, perhaps, attempted the impossible in treating of the "ventilation of plans" in a single short chapter.

Mr. Bryson is a strong and convincing advocate of

the direct method of expressing ventilating resistance—a method which he places to the credit of Cambessédès—and for his presentation of that side of the subject we have nothing but praise.

The reputation which Messrs. Arnold have gained as the producers of well-printed and capably edited scientific text-books is not likely to be diminished by this volume, the virtues of which considerably transcend the defects.

Bibliographie de la relativité : suivie d'un appendice sur les déterminants à plus de deux dimensions, le calcul des variations, les séries trigonométriques et l'azéotropisme. Par Maurice Lecat, avec la collaboration de Mme M. Lecat-Pierlot. Pp. xii+291+47. (Bruxelles : M. Lamertin, 1924.) 90 francs.

IT is a striking instance of the acceleration of ideas in the modern world that a theory which five years ago was known only to a narrow circle of mathematicians engaged on an abstract and abstruse problem, and until then unverified, should have produced already a flood of literature. The mere catalogue of the books and articles written on the principle of relativity occupies 290 pages, and an appendix of more or less associated mathematical works, another 47. A whole century elapsed before the hypothesis of Copernicus became the universally accepted Copernican theory, and at least one generation passed before Newton's gravitation formula received general recognition. Of course in neither case was the proof so dramatic and the conviction so immediate and the interest so intense as in the eclipse expedition of 1919. The nearest analogy to that was Pascal's experiment with the barometer on the Puy de Dôme in 1648, which established the theory that the atmosphere has weight.

The author's incentive to compile this catalogue and the diligent application it required are set forth in a rather curious preface, in which the writer, a pacifist and cosmopolist, bemoans the militarism of his country and its government. The relevance is not quite clear. He tells us, however, the significant fact that numerous authors, almost all university professors, begged him with a touching insistence, that he would omit some of their writings, if not all, because they were completely false. To this request, however, he informs us he was inexorable. No doubt selection would be difficult and hazardous, but it seems hard that a writer should be held to the fatal ὃ γέγραφα, γέγραφα.

The Birds of Portugal. By William C. Tait. Pp. xii+260+10 plates. (London: H. F. and G. Witherby, 1924.) 18*s.* net.

WHEN one thinks of the many ornithologists and bird-lovers in Great Britain, and of the numerous books on British birds, it is surprising to learn that Mr. W. C. Tait knows of only one native field ornithologist in Portugal, where he has himself for long been resident, and that the literature on Portuguese birds is exceedingly meagre. His own book on the subject fills a gap in a useful way. It is almost entirely devoted to a systematic account of the status in Portugal of each species, no attempt at descriptions of birds being made. An introductory chapter describes the physical characteristics of the country. A second general chapter deals with migration, giving a somewhat disjointed but nevertheless interesting account of its Portuguese aspects. Many species which are native to Northern Europe are only winter or passage visitors to Portugal, and that country is perhaps interesting to us, ornithologically, chiefly by reason of its place in the migratory path of our own summer birds. In an appendix, Mr. Tait gives a list of all the marked birds which he knows to have been recovered in Portugal, although we notice that this is not quite so complete as it could have been made from published sources; nearly thirty species are represented in the list, in which birds marked in the British Isles and in Holland bulk most largely (little marking is done in France), although there are also birds from Germany, Denmark, Sweden, Czecho-Slovakia, and Switzerland.

Developments in Power Station Design. By E. Austin. (The Engineer Series.) Pp. xv+271. (London: Constable and Co., Ltd., 1923.) 31*s.* 6*d.* net.

THIS book will be found useful and interesting by every one connected with the design of electrical power-houses or associated with the installation and operation of steam and electrical plant. The author looks forward to the time when every factory will be driven electrically and power production will be confined to very large power stations. Before this happens, however, it is essential that every manufacturer who generates power for his private use should cut down his consumption of fuel to a minimum. This is highly desirable, not only to reduce his working expenses but also to prevent waste of the nation's coal resources.

There are excellent chapters on pulverised coal-plant, low temperature carbonisation, and waste heat. The boiler-house plant is discussed very thoroughly, but we should have liked a more thorough discussion of the electrical side of power generation. It is a pity that up to the present time very little progress has been made with the huge scheme outlined by the Coal Conservation Sub-Committee in 1918. This is partly due to the lack of interest in the subject by the nation.

Cobalt Ores. By Edward Halse. (Imperial Institute: Monographs on Mineral Resources, with special reference to the British Empire.) Pp. ix+54. (London: John Murray, 1924.) 3*s.* 6*d.* net.

THIS small work forms one of the series of Imperial Institute Monographs and follows the familiar arrangements of its predecessors, commencing with a description of the occurrences of cobalt ores and the uses to which the metal is applied, this being followed by a chapter on the sources of supply of cobalt ores within the British Empire and in foreign countries. As usual, a useful bibliography completes the volume. The work has been quite satisfactorily done, though it must be admitted that the task in this case was a tolerably easy one, as a good deal of the matter was ready to hand. The Canadian Department of Mines has published a good deal of information about cobalt, particularly the researches on the metal and its alloys by Dr. H. T. Kalmus. Naturally the statistical and other material collected by the Imperial Mineral Resources Bureau has been made use of. The little work can be recommended to any one who desires a concise review of the occurrences and distribution of the ores of cobalt.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Use of "Shear" in Geometry.

WHEN an area or solid is subjected to "shear," although the boundaries are changed in form, the area or volume remains constant.

This characteristic of shear may be applied in the demonstration of a large class of geometrical propositions, and I have found it useful in many physical inquiries.

If any plane area is supposed to be divided into straight linear elements, parallel to a given axis, and if each element is caused to move in its own direction by an amount proportional to its distance from the axis, then if the axis passes through the centre of inertia of the area, the result is a pure shear. In any other case both shear and displacement are produced, or if the axis is infinitely distant, the

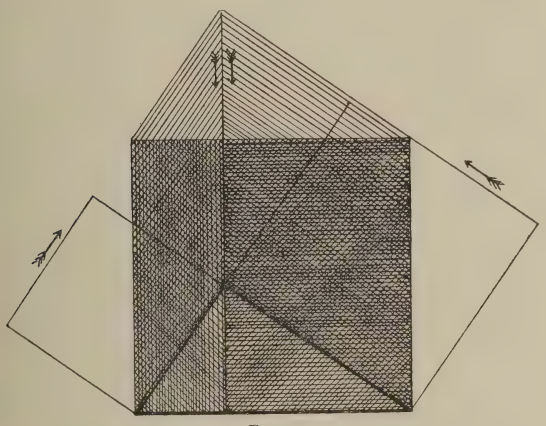

FIG. 1.

change becomes a simple displacement without distortion.

The constructions and proofs furnished by the method of shear seldom require the use of words or writing, but may be compared to the putting together of picture-puzzles in which the pieces, while retaining a constant area, may be changed in form and position according to certain rules.

The following examples will indicate the kind of propositions to which the shear method is applicable:

(1) If one side of a triangle is given, and a line parallel to that side is drawn through the vertex, then by a single shear, that is, by shifting the vertex along the line, every possible triangle can be formed which has the same base and area as the original triangle.

(2) If two sides of a triangle are given, the area of the triangle is a maximum when the angle contained by the given sides is a right angle.

(3) From this it follows that the maximum area of any polygon the sides of which are given occurs when the angles of the polygon lie on a circle;

(4) and, hence, the maximum area which can be enclosed by a line of given length is a circle.

(5) By two shears, any triangle can be converted into a rectangle of equal area.

(6) By two shears, any rectangle can be converted into an equal square.

(7) Such of Euclid's propositions as relate to equality of areas can be dealt with by shear. As an example the proof of Prop. 47, Bk. I. is shown in Fig. 1. (Here the successive pairs of shears are indicated by single and double hatching.)

(8) A circle of radius r can be converted into an ellipse with semi-axes a and b ($r^2 = ab$) by a shear the magnitude of which is $(a-b)/r$ (see Fig. 2).

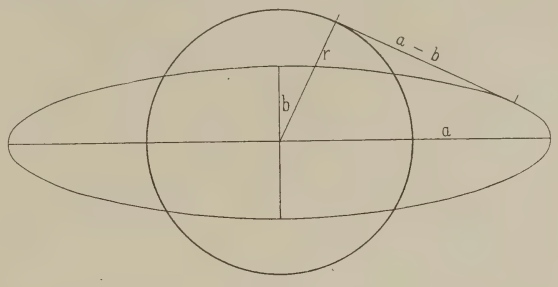

FIG. 2.

Often there are several ways of arriving at the same result, and in complex cases (especially in three dimensions) it requires some practice to select those shears which produce the required change of form with the fewest operations. It is always possible, however, by the shear method to transform any plane or solid figure into any other assigned form having the same area or volume.

A. MALLOCK.

9 Baring Crescent, Exeter,
June 6.

Mendelism and Evolution.

ALTHOUGH I do not wish to defend Dr. Annandale's theoretical views, or to maintain that his evidence for his conclusions was sufficient, I feel tempted to make some comments on Mr. J. S. Huxley's letter in the issue of NATURE for June 7. First, I should like to point out that Mr. Dover was using an unfortunate expression in writing that "some inherited characters at least are persistent." It is generally agreed that all inherited characters are more or less persistent. It would seem that Mr. Dover meant that some effects of environment are inherited.

Mr. Huxley states that no biologist disputes that "the differences seen between species, genera, etc. . . . stand in some intimate relation with their environment." The proposition is disputed by myself for one, and by Mr. Bateson for another, and Mr. Huxley will admit that Mr. Bateson at least is a biologist. It is necessary for "progress in evolutionary biology" to distinguish between those characters which are obviously in relation to the environment, and those which, although diagnostic of species, genera, etc., exhibit no such relation. There is no evidence concerning the majority of specific characters that they are in intimate relation with the environment.

Mr. Huxley considers that experiment is the one thing necessary for the elucidation of evolutionary problems, but I have long ago come to the conclusion that experiment by itself is of no more value than observation by itself. Two other things are essential —(1) a real and thorough understanding of the phenomena to be explained and the problems they present, (2) sound reasoning applied both to observation and experiment.

Instances are almost daily afforded of unsound reasoning from experiments, leading to erroneous conclusions applied to problems which are imperfectly understood. For example, Prof. T. H. Morgan discovered that castration of hen-feathered cocks was

followed by the development of normal cock-feathering, and drew the conclusion that secondary sexual characters were, or might be, the by-products of internal secretions the real "utility" of which was quite different. J. T. CUNNINGHAM.

University of London Club,
21 Gower Street, W.C.1.

MR. HUXLEY seems to have missed (NATURE, June 7) the main point I wished to emphasise, namely, that while criticism of one investigator's views by another is always valuable, it is stretching the point to attempt to define the grounds on which an opinion may be advanced. It is natural for a man who has studied a group of phenomena from a certain viewpoint to formulate an opinion as the result of his studies. If the admitted limitations of a paper were appreciated, together with the difficulties under which some zoologists work, I imagine they would be free from the type of criticism under discussion. That Dr. Annandale's opinions may have been strengthened or modified by experimental data I do not deny, and if Mr. Huxley's letter directs attention to the neglect of experimental work in India it will have served a useful purpose; but, as I said, it is expecting too much to require a man already engaged in studies so diverse as Dr. Annandale's to supply the need himself.

Mr. Huxley's assumption of my lack of knowledge of his studies on the courtship of birds is perhaps natural. I may mention, however, that I have always followed his writings with interest, and I ask his indulgence if I missed the ecological importance of the paper he refers to, and previously regarded it as a valuable contribution to bird "behaviour," or rather psychology.

With reference to Mr. Huxley's concluding epigram I would point out that, apart from the limited scope of Dr. Annandale's paper, attempting as it did only correlation, it seems to be inconsistent with recent opinions on the notion of cause. Mr. Bertrand Russell ("Mysticism and Logic and other Essays," pp. 180-208: London, 1919) regards the word "cause" as "so inextricably bound up with misleading associations as to make its complete extrusion from the philosophical vocabulary desirable," and if I interpret him aright he proves that the idea of causation (absent in advanced sciences) as a fundamental axiom of science is erroneous, and that the supposed "causation" is really correlation. Accepting this argument, the geneticist is also correlating, though in a manner quite different from the methods of the pure ecologist. CEDRIC DOVER.

London, June 12.

Frequency Curves of Genera and Species.

IN NATURE for June 7, Mr. Tate Regan refers to "the series x, $x/2$, $x/3$, $x/4$, etc. . . . x/x, representing the number of genera with 1, 2, 3, 4, etc. species in a group where the sizes of genera are purely a matter of chance." I am unable to attach any *definite* meaning to the phrase "are purely a matter of chance," since the sizes might be "a matter of chance" in many different ways, and I do not see what process Mr. Tate Regan has supposed to be followed. Will he be so good as to state exactly in what way he supposes the systematist to operate, and to show how the series in question arises from his operations?

G. UDNY YULE.

St. John's College, Cambridge,
June 10.

THE simple graph published in NATURE of June 7, p. 822, by Mr. Tate Regan demonstrates the result of log plotting $xy=n$, but is otherwise irrelevant. For if the matter were so simple as that, then an infinity of species per genus would be as probable as an infinite number of monotype genera, and there would be no room on the earth for us. The introductory chapter of Mr. Udny Yule's remarkable paper in the Philosophical Transactions is carefully written for the non-mathematical biologist, and should be read by all such. W. LAURENCE BALLS.

The Orchard House, Bollington Cross,
Near Macclesfield,
June 18.

Study of Explosions.

WHETHER anything physical and instructive about the atmosphere can be learnt from a study of purposely produced explosions, I am not sure. Ordinary explosives must waste much of their energy on the earth; and if atmospheric waves are wanted, it would seem better to explode a balloon filled with a detonating gas, say a mixture of hydrogen and oxygen, at a considerable height. Gas exploded without any rigid envelope, as in a soap-bubble, makes a tremendous noise, since the energy is wholly expended on the atmosphere. OLIVER LODGE.

Ball Lightning.

HAVING read the article on Ball Lightning by Dr. Simpson in NATURE of May 10, p. 677, I thought the following account of what I once witnessed, and believe to have been ball lightning, might prove of interest to some of your readers.

In August 1900 I was staying at the Voxli Hotel, Hankelid Fjeld, Telemarken, Norway. The hotel is 776 metres above sea-level and not far from the Hankelid Pass (1123 metres). On August 21 there was a terrific thunderstorm, towards the end of which I saw the particular lightning flash which I think must have been ball lightning. I will quote the actual words in which I attempted to describe the occurrence at the time.

"We were sitting in the dining-room at supper (precisely 8 o'clock Norwegian time); on an ordinary day it would still have been good daylight, but owing to the storm it was only just light enough to see the outline of the hills on the opposite side of the lake. This was the direction (south-west) from which the storm was coming, and I had been watching the particularly vivid lightning for some time, when suddenly I saw a streak of 'yellow,' apparently about one inch broad, dart from the sky just above the top of the hill opposite and, gradually falling, make straight for where I was sitting. I was too spell-bound to move, and the length of time of the whole occurrence was too short to call the attention of those who were sitting with me. I remember having the sensation that it must hit my forehead, when just as it got in front of the hotel window it changed to a ball of dazzling yellow fire (about the size of a cricket-ball) and then burst with a frightful crash, emitting volumes of violet-coloured flame, which spread in all directions. This must have happened in one or two seconds, but for several minutes afterwards I was completely dazed.

"Next day I examined the ground and found the track of the flash commenced just 20 metres (no yard measure to be had here) from the hotel window. The whole of the surrounding space is covered with small sods and branches of trees, and two or three small trees are uprooted. The most noticeable thing is a

furrow in the ground, in plan shaped like a horse shoe, but curved at both ends. Its entire length is 44 metres: its breadth varies from 7 to 24 centimetres and its depth 4 to 12 centimetres. In the path of the furrow is a large granite boulder from which two respectable-sized lumps have been cut off; one I could just lift, the other (thrown 5 metres from the boulder) I could just move but could not lift. The furrow then skirts round the edge of the boulder for a long distance, in places being completely underground. It becomes visible again farther on, passing under the roots of a small shrub, and shortly after meets the face of another rock 3 metres high. The discharge must have passed up this face, for it has left a track on the top of the rock, where moss has been torn off; but just beyond the bare rock falls into the lake and nothing more is visible."

I have some "snap-shot" photographs of parts of the track of the furrow; they are not large enough to show much detail, but I shall be glad to forward them for inspection to any one interested.

ARTHUR W. CROSSLEY.

Shirley Institute,
Didsbury, Manchester.

The Spiders of the Madeira Islands.

WHEN in the Madeira Islands a few years ago I collected some spiders, which have now been kindly determined by Dr. N. Banks. Although the collection is small and relatively unimportant, it suggests some problems of general interest. At and about Funchal, Madeira, I obtained *Cyrtophora citricola* Forsk., *Epeira crucifera* Lucas, *Mangora acalypha* Walck., *Teutana grossa* Koch, *Lepthyphantes tenuis* Blk., *Xysticus insulanus* Thor., *Clubiona decora* Blk., and *Chiracanthium albidulum* Blk. In the island of Porto Santo I collected *Lycosa maderiana* Walck. (abundant under stones), *Pholcus phalangioides* Fuessl. (in an outhouse), *Argiope trifasciata* Forsk. (this African species also abounds in Madeira), *Ariadne portosancti* Kulcz., *Dysdera crocata* Koch, *Dictyna* (*Ergatis*) *puella* Sim., *Epeira crucifera* Lucas, *Ero aphana* Walck., *Xysticus insulanus* Thor., *Thanatus vulgaris* Sim., *Teutana grossa* Koch, and *Zilla x-notata* Clerck.

The spiders of Madeira have been discussed by several authors, comparatively recent papers being those of Warburton (1892), Van Hasselt (1891), Bösenberg (1895), Schmitz (1895) and Kulcznski (1899). I have not seen Kulcznski's account of the Schmitz collection, though I saw the spiders themselves in the Seminario at Funchal. Warburton lists the 64 species then known from the Madeiras, 35 being supposedly endemic. As the islands are of the oceanic type, a careful study of the spider fauna should give interesting results. The means by which spiders might reach the islands are probably four: (1) Young spiders on gossamer threads floating through the air, (2) introduction by man, (3) on the plumage of birds, (4) on floating objects. The first two may be presumed to be far the most important. Such forms as the Argiope and Pholcus may be safely put down as introduced. *Epeira crucifera* seems to be a recent introduction; it is not mentioned (at least under that name) by Warburton. It would be interesting to determine whether the species likely to be carried on gossamer threads are prevalent in the islands, and whether some species frequently so carried are absent.

The differences between the spider fauna of Madeira and that of Porto Santo have not been clearly made out, and it is not known whether there are any special forms on the islets off Porto Santo. According to J. Y. Johnson (1863) there are three species of the large snail-eating wolf-spiders, *Lycosa maderiana* confined to Porto Santo, *L. blackwallii* Johns. to Madeira, and *L. ingens* Blk. to the Desertas. The snails on which they prey, representing endemic genera, are presumably much older inhabitants of the islands. Possibly there are endemic genera of spiders surviving in remote places. The collecting done so far has been mainly in the vicinity of the towns, or in the towns, and it may be that it does not fairly represent the fauna of the Madeiras. T. D. A. COCKERELL.

University of Colorado, Boulder,
May 29.

The Scotoscope.

CAN any of your readers explain the principle of the scotoscope which Pepys defines in his diary (Aug. 13, 1664) as an instrument enabling objects to be viewed "in a dark room"? It seems scarcely credible that in the seventeenth century any such instrument could have existed, and bearing in mind the lack of science which Pepys evinced, one is tempted to wonder whether he had misunderstood the instrument-maker's "camera obscura," which would account for his speaking of a "dark room" instead of saying "in darkness" or "in the dark."

Only one other reference (without definition) to the scotoscope is given in the Oxford Dictionary, and the word is generally defined in the dictionaries, through reliance on Pepys, as being what it suggests—an instrument for revealing objects in the dark. If it was merely a synonym for the camera obscura, such a definition is misleading. CHARLES E. BENHAM.

Colchester, June 18.

Chimæras Dire.

DR. FINKLER'S experiments on the transplantation of the heads of insects have attracted both scientific and popular attention to a degree which was marked on the one hand by an exhibit last year at a Royal Society soirée and, on the other, by mention in the pages of *Punch*. It is desirable, therefore, to direct attention to an emphatic repudiation of his claims which has just been published in the *Zeitschrift für wissenschaftliche Zoologie* (vol. cxxiii. pp. 157-208) by Hans Blunck and Walter Speyer.

It will be recalled that Finkler stated that the heads of adult insects could be successfully grafted on to bodies of the other sex, and even on to bodies of distinct species belonging to widely different genera. He inferred, rather than observed, the union of tissues following the operation and hastened on to describe its remarkable results, physiological and psychological. The head of an herbivorous water-beetle persuaded a carnivorous body to be content with, and seemingly to digest, a vegetable diet; a male head led a female body into unwonted perversities; and a Dytiscus strove to moderate the colouring of its wing-cases to suit the sober tastes of its new Hydrophilus brain. Experiment was added to experiment, and water-boatmen abnormally coloured by inverted illumination transferred the abnormal coloration with their heads to other individuals not so illuminated.

It was to be expected that a field of work offering such remarkable possibilities would speedily be occupied by other investigators. The living material is easy to obtain, the technique is simple ("an Roheit schwerlich zu übertreffen," say Blunck and Speyer), and the results are got in a brief space of time; and yet no one, with the solitary exception of Dr. Kammerer, appears to have claimed success in repeating even the less startling of Dr. Finkler's experiments.

Now Dr. Blunck and Dr. Speyer (already known by a long series of anatomical and biological researches

on the very water-beetles that were among the chief of Finkler's *corpora vilia*) come forward with a detailed and documented confession of their failure, after persistent attempts, to confirm the simplest of Finkler's results. They followed carefully his instructions as to procedure, and only after this failed did they try to refine upon his technique. The severed heads certainly adhered to the bodies on which they had been placed, cemented, in fact, by the coagulated blood which dried to a chitin-like hardness, but in no case did the insects survive longer than others in which, after decapitation, the wounds were stanched with a little melted wax; in no case did the chimæras behave differently from the headless trunks; in no case did stimulation of the head produce reflex movement in the body or its limbs. Microscope sections showed no attempt at regeneration or union of the tissues, but instead, a progressive necrosis, leading more or less quickly to the death, first of the head and later of the trunk. These results followed, even in cases of replantation where the severed head was replaced at once on the body from which it had been detached.

Dr. Finkler may of course be able to point out to us where the German experimenters have gone wrong, but there seems to be a familiar ring in their complaint that he has ignored requests to produce his chimæras, alive or dead, for investigation by others. He cannot ignore the challenge of their final words: "Die Wissenschaft hat angesichts der allen Erfahrungen widersprechenden Angaben des Wiener Autors keine Veranlassung, sich weiter mit ihm und seine Schriften zu beschäftigen." W. T. CALMAN.

British Museum (Natural History),
South Kensington, S.W.7.

The Origin of Ores.

REFERRING to the very kind review by Prof. H. Louis of my book "The Geology of the Metalliferous Deposits" in NATURE of June 7, p. 812, I wish to direct attention to one point. Prof. Louis quotes the following sentence: "It would perhaps be too much to say in the present state of our knowledge that all primary ore-deposits are of igneous origin, but this is a view which may very likely be established as a result of future work." He then goes on to instance the hæmatite deposits of Cumberland as ores which are certainly not of igneous origin. With this, of course, I entirely agree, and I wish to say that my statement was certainly never meant to include them, as may be seen by referring to p. 330 of my book. The emphasis in the sentence quoted is on the word *primary*, whereas I regard the hæmatites of Cumberland and northern Spain as secondary ores. Should a second edition of the book be called for, steps will be taken to make this point quite clear.

R. H. RASTALL.

Christ's College, Cambridge.

Exhibit of Pure Science at the British Empire Exhibition.

IN NATURE of June 21, p. 896, there is a reference to the instruments exhibited under my name in the Royal Society's section in the Government Pavilion at the British Empire Exhibition dealing with the measurement of atmospheric pollution. I should like to make it clear that the credit for the original idea underlying the contrast photometer exhibited is due to Mr. L. F. Richardson. It is a development of the method described by him in the Proceedings of the Royal Society, A, vol. 96, 1919. The principle was further elaborated by the Photometric Sub-Committee of the Advisory Committee on Atmospheric Pollution, my share being only that of getting out a workable design and making the experimental instrument. I was fortunate in getting at the first attempt an instrument with remarkable sensitiveness and accuracy, which required practically no alteration and enabled a measure of light obstruction by fog to be obtained.

During the smoke fog in the afternoon of November 26 last in South Kensington, a fairly dense fog containing about $2\frac{1}{4}$ milligrammes of soot per cubic metre and about 24,000 smoke particles per cubic centimetre, the obstruction of light in 50 feet was 46 per cent. In the morning of the same day at 11.45 the amount of suspended matter was 3·8 milligrammes per cubic metre and the number of particles 82,000, the obstruction of light in 50 feet being 75 per cent.

J. S. OWENS.

Advisory Committee on Atmospheric Pollution,
47 Victoria Street, Westminster,
London, S.W.1, June 25.

Birds as a Geological Agent.

ALL along the tops of the cliffs of the Undercliff from Ventnor to Blackgang empty shells of the common limpet are found in large numbers, and it has usually been assumed that their shape has caused them to be blown by the wind from the beach over the cliffs. There are so many of them that I have found it difficult to believe this theory, and on mentioning it to a local naturalist, he has assured me that he has seen rooks and jackdaws pick them up from off the rocks while living, and convey them in their beaks to the trees where they roost and nest and to other places, and after feeding on them, cast away the empty shells. This may account for the mixture of marine shells with land shells in some of the tertiary strata which is sometimes inexplicable.

EDWARD A. MARTIN.

285 Holmesdale Road,
South Norwood, S.E.

A Substitute for the McLeod Gauge.

THE letter on the McLeod gauge appearing in NATURE of November 3 has only just come to my notice.

There may be gauges which, having been compared with a McLeod gauge, will give equivalent readings, but there is no substitute for the McLeod gauge in its perfect measurement of low pressures, expressed in height of mercury column.

If the McLeod gauge is used with proper knowledge, it *will* indicate aqueous vapour as well as permanent gases. When the gauge is so proportioned that the difference of the height of the mercury in the capillary columns is less than 4 mm. and the temperature is above 0° C., any aqueous moisture present will act as a permanent gas and will give a true reading of the pressure absolute.

HENRY A. FLEUSS.

47 Albert Road, Caversham, Reading,
June 16.

Ceremonial Banquets.

I HAVE recently received an invitation to forward a cheque for two guineas, as a fee for attending the banquet in connexion with the Kelvin Centenary. It is difficult to understand why the memory of a man of simple habits should call for such a sumptuous repast, or why scientific workers of frugal habits should be excluded from such a celebration. In view of the growing tendency to limit functions such as these to men of means rather than to men of science, it is surely time to make a protest against the methods of organisation which lead to so undesirable a result.

F.R.S.

The Plant Commonwealth and its Mode of Government.[1]

By Sir FREDERICK KEEBLE, C.B.E., F.R.S.

THE plant commonwealth lies within the contours of an individual plant — rose, lily, grass, oak tree or any other. The physical features of the commonwealth have been surveyed and are well known. Notwithstanding their differences in outward aspect, all the members of the commonwealth—root, stem, leaves, and flowers—own a common plan of organisation. As the human being is the unit of a commonwealth of nations, so is the cell or protoplast the unit of the plant commonwealth. Just as certain men have the appearance of simplicity, so has the plant cell—a minute mass of nucleated cytoplasm, bounded by a solid wall of cell-wall substance, of such small dimensions that one thousand cells might lie comfortably side by side along the diameter of a penny piece. Yet, as is the case with man, the simplicity of the cell is illusory. The cell lives, feeds, respires, grows, and does many different kinds of work. Nor does it live unto itself alone. In all its manifold activities the cell influences and is influenced by other of the well-nigh innumerable cell units of the commonwealth. Indeed, the messages which by word of mouth, by post and telephone, telegraph and wireless, pass between members of our own commonwealth and leave us but little peace, are rare by comparison with those sent and received by the living cells of plants. Throughout life they are always "listening in." In the simplest plants of all—the unicellular plants—the cell is the commonwealth. So is it in the highest (multicellular) plant at the moment of the rebirth of the individual within the ovary of the flower of the mother-plant. All plants begin life each as a single, minute mass of semi-fluid nucleated protoplasm. Every activity evinced by this living particle shows alike the diversity of its unrecognisable parts and the integrity, that is, the individuality of the whole, and throughout life diversity of activity and oneness or individuality alike persist.

From simple raw materials the cell-protoplasm restores and augments itself, and gradually stage by stage the plant carves out its body from this increasing mass of living substance. The primal cell grows and divides to form two daughter cells, each, like the mother cell, consisting of nucleated protoplasm invested by a wall or coat of cell-wall substance. Yet though a solid wall divides them, the daughter cells are not isolated from, but remain in communication with one another. For, in the first place, the separating wall is very thin and soluble substances may pass across it readily, and, in the second place, fine strands of cytoplasm radiating from the central mass penetrate into pits in the cell wall and, joining or all but joining with corresponding strands from a neighbouring protoplast, maintain vital touch between the cells. So in like manner the daughter cells divide, and the cells to which they give rise maintain vital contact by their protoplasmic connecting fibres, until after many divisions the embryo is recognisable within the swelling seed. If by some magical liquor the cell walls and all the non-living contents could be dissolved away and the transparent semi-fluid protoplasm made hard and visible, the contours of the plant would still be recognisable.

Not all of the cells which compose the body of the embryo plant remain unchanged. Some, it is true, appear to do nothing else but grow and divide. They are the producer or embryonic cells destined throughout the life of the plant to carry on the work of cell formation. Groups of them are to be found at all ages of the plant in the growing point of the root and in the buds on the stem. In long-lived plants, after a thousand years and many thousands of divisions, these embryonic cells still retain their powers of cell-formation. Theirs is the gift of perennial youth; they never grow up. Once established, a growing point exercises a dominating influence over the broods of cells which it throws off by the division of its component embryonic cells. In some way, as yet unknown, it influences or perhaps determines the morphological fate of its offspring. For, as has been shown recently, a minute fragment of a root tip $\frac{1}{25}$ in. in thickness, if cut off and fed with mineral salts and suitable proteins, grows, divides, and in the cells which it produces, the same differentiation appears as in the normal root.

Other cells of the plant body soon cease to divide, but undergo no very great change of form. They become the general working cells of the body. Others assume curious and characteristic forms and, grouped together, constitute gangs of cells—skilled cellular artisans—to each of which some special task is assigned. Yet other cells or groups of cells undergo greater change of size and shape. For example: those destined to give rise to the woody vessels along which sap passes from root to stem grow wide and very long, join above and below in single file with cells like themselves, build thick and woody longitudinal walls, often beautifully sculptured, and, losing their contents and dissolving away their cross walls, form long uninterrupted tubes—mere aqueducts. It requires but little imagination to realise how imperative must be the constraint brought to bear on those wood-forming cells to induce them thus to immolate themselves for the benefit of the plant commonwealth. Their fate suggests that as the commonwealth develops the cellular units suffer more and more curtailment of liberty. Each is constrained to endure a limitation of freedom, and each imposes a limitation on that of other units of the plant body. In this compromise between liberty and social obligation a new and higher unit is fashioned—the individual plant, that is, the plant commonwealth. If this way of regarding the individual be correct, it must be of interest to explore the nature of the messages which, passing between members of the plant body, bind them together and determine the subordination of the cells and their integration into an individual. On these trifles, "light as air but strong as iron," the existence of the commonwealth is based. It is to the origin, nature, and effects of these messages that I propose now to refer.

I know of no better way of approach to this task than by describing—at the risk of the smile it may evoke—the strange things that happen when a potato is peeled. An immediate effect of the operation is the setting up of a state of fever. During this wound fever the temperature of the tissues near the cut rises

[1] Discourse delivered at the Royal Institution on Friday, March 21.

rapidly as a result of increased cell respiration. The wounded cells die; those of the layer next to them, no longer hemmed in on all sides, find some relief from the bondage which held their activities in subjection. They grow out to form bladder-like or tubular projections. In the welter and confusion due to loss of touch with other cells, these cells break rank and become a law unto themselves. Their growth is, however, limited and aimless, and presently withering and turning brown, their dead remains form a thin dry skin over the wound. Behind the broken ranks the orderliness of behaviour of the cell layers is maintained; but it is a new order which these cells obey. They form a new front. Dividing rapidly and in a regular manner, these cells come to present the appearance of rows of microscopic bricks. When the originally single layer of dividing cells has given rise to several layers, the cells of the outermost form thick corky walls, lose their living contents, and come to consist of mere empty shells fitting as hollow bricks might fit closely one with another. Thus by the formation of wound tissue is the wound healed. Until recently, nothing was known of the provenance of the new orders which stir the cork-forming cells to activity and, releasing them from obedience to previous orders, cause these cells to renew their youth and reassume the power of division. But it is now known as a result of investigations made by Prof. Haberlandt that the renewed activity is called forth by messages from the stricken and dying cells.

The origin and nature of these messages may be determined by very simple experiments. For example: if the bulbous stem of a kohl rabi (turnip-stemmed cabbage) be cut across, all the changes just described may be observed to take place. But if the cut surface be rapidly and thoroughly washed with a stream of water, little or no cork formation occurs; the wound does not heal. When, however, the washed surface is covered with a layer of brayed-up cells of kohl rabi tissue, cork formation proceeds even more vigorously than it does in the unwashed wound. Whence it is to be concluded that messages are sent by the wounded cells and that the messages are of a chemical nature. As they die, these cells liberate some substance which, diffusing into the living cells, quickens them to activity and provokes their division. This stimulator of specific change may be spoken of as a wound hormone. Its presence may be demonstrated experimentally in many different kinds of wounded tissue, and in none better than in the succulent leaves of sempervivum and sedum. Leaves of these plants may be readily torn asunder without mechanical destruction of their cells; for the cell walls between the cells give and split so that the protoplasm of the cells remains intact. Now it may be shown that whereas by cutting a leaf and thereby destroying numerous cells the cell division provoking hormone is produced, by tearing it the hormone is not produced. The wound hormone, this message of healing, is sent out by the dying cells. Thus may plants rise by stepping-stones of their dead cells to higher things.

Further insight into the circumstances in which wound hormones are produced may be obtained by observing the effects which follow upon mechanical injury of delicate plant-tissues, as, for example, the multicellular hairs so often found on leaves and stems. These structures are formed each by the outgrowth and division of a single surface cell. This cell divides to form a row of cells placed end to end; after a few divisions growth ceases, and the constituent cells of the hair divide no more. If, however, the hairs on the leaf or stem of a coleus or zonal pelargonium be maltreated by cutting or pinching or by less drastic means, as, for example, rubbing gently between the fingers or brushing with a hair brush, cell division may in certain circumstances be resumed. If a hair be cut across with a sharp instrument the cell cut into dies at once, its contents dry up, and no division occurs in the remaining intact cells. But if the instrument, in removing the top of the hair, also bruises the cell beneath the one cut into, the bruised cell enclosed in its wall, though it dies ultimately, has time to prepare its message, and its last will and testament consists in wound hormone which, passing to the next-of-kin, endows that cell with renewed powers of cell division. The wound hormone, diffusing into a cell, exercises an attraction on the nucleus which moves up in the direction of the injury, and in consequence nuclear divisions and subsequent division occur in the part of the cell near the wall across which the hormone diffuses. In some plants, as, for example, the zonal pelargonium, the basal cell of the hair appears to resist injury more than the other cells, and hence it may happen that when the stem bearing the hairs is brushed not too harshly, all the cells of a hair are killed except the basal cell. If this sole surviving cell, though damaged as may be seen by a puckering of its wall, has not been mortally injured, it produces wound hormone and thereby stimulates itself to cell division.

It may, and I think it will be that these discoveries are destined to throw light on many obscure phenomena in plants. Thus it has long been known that by wounding a plant a turmoil may be set up which spreads from the seat of injury to the uttermost parts of the plant. When a branch of a tree is lopped there are repercussions in the roots buried deep underground. The turmoil is visible under the microscope. In normal circumstances the protoplasm of a plant cell presents no sign of movement; but in certain circumstances an incessant restlessness very marvellous to witness overcomes it. All its granular mass except the layer next the cell wall begins and continues long to circulate around the cell or else to stream up and down along certain lines. When tissues are injured this streaming or circulation of protoplasm begins in cells near the wound, infects the cells next to them, and so on until, like bees disturbed in a hive, the myriad protoplasts of the plant are all in active movement.

In the light of the experiments with wound hormones, it would seem probable that the propagation of the disturbance which leads to streaming is due to some chemical message passing by diffusion from cell to cell. Again, it would seem possible to ascribe the remarkable behaviour of the fertilised egg cell to the influence of a wound hormone. As is well known, the egg cell of a plant or animal remains quiescent until it is penetrated by the male reproductive cell. Soon after this event the fertilised cell begins actively to divide, and continues growth and division until the embryo has been formed. Ingenious experimenters

have shown that egg cells of the lower animals and of some plants may be caused to undergo division and to produce embryos even in the absence of fertilisation. Thus the unfertilised egg of a frog pricked by a needle has been caused to undergo division and development, and to give rise to fatherless tadpoles. Hence there would seem to be little doubt that, in normal fertilisation, the abrupt entrance into the egg cell of the male reproductive cell leads to the production of a wound hormone which acts specifically in provoking cell division.

It might be objected that such an hypothesis presupposes an almost incredible delicacy of protoplasmic organisation, but the objection has no weight with the plant physiologist who knows from long experience that disturbances of protoplasm, often so slight as to escape our own powers of perception, may suffice to produce marked and far-reaching effects in plants. The exposure of one side of the tip of the seedling leaf of oat or other grass to direct sunlight for periods of so brief a time as $\frac{1}{2000}$th of a second suffices to interrupt the uniformity of its upright growth and make it do obeisance to the sun. The tendril of the passion flower has a receptiveness so acute that the hanging upon it of a thread weighing no more than $\frac{1}{4000}$th of a milligram suffices to deflect the tendril from its course of growth. It curves in the direction of an incubus, the weight of which would have to be increased tenfold before we, if it were placed upon the skin, could be made aware of it by our sense of touch. The human eye is apt to distinguish small differences of light intensity. When we are young, our eyes can perceive the difference between a ninety-nine and a hundred candle-power lamp. As we grow old, acuteness of perception fails, and we are lucky if we can tell the difference between lights of one hundred and ninety-six candle-powers. A leaf can "tell the difference" between one hundred and 98·7 candle-power, so that its sensitiveness, as expressed by responsive movement, is equal to that of a fairly young eye. The trained eye is a wonderful instrument for perceiving whether or no a line be truly vertical, but I doubt whether its power is greater than that of the root of any plant. More than once a delicate experiment in plant behaviour has come to grief because the experimenter failed to notice that his table was not absolutely horizontal, and in consequence his plants not vertical. The plants themselves took heed of the displacement and set to work to rectify it to the undoing of the experiment.

(*To be continued.*)

Large Crystals of Iron.

THE paper by Prof. Edwards and Mr. Pfeil presented at the May meeting of the Iron and Steel Institute on "The Production of Large Crystals by Annealing Strained Iron" has now brought iron into the rapidly growing list of metals which can be obtained in the form of very large crystals. The research follows on a preliminary paper presented to the Institute by the same authors a year ago, in which they dealt with the commercial importance of coarse crystallisation in a number of defective stampings which had come into their possession. Methods of producing large metallic crystals may be classified under the following heads: (1) By slow cooling of the melt; (2) by drawing a rod slowly out of the melt; (3) by straining to a critical amount a test-piece composed of small metallic crystals, followed by heat treatment; (4) by the simultaneous application of strain and heat treatment to a metal wire. The method adopted by the authors is No. 3, which was introduced in 1921 by Carpenter and Elam in the case of the metal aluminium, and the large crystals produced are very similar in form.

It could have been predicted that iron would be more difficult to prepare by this method in the form of "single crystal" test-pieces than aluminium, for two reasons: (1) That no suitable form of commercial iron exists; and (2) that no heat treatment can be carried out above 900° C. on account of the A_3 change point at which the α to γ change occurs. Another difficulty presented itself in the course of the research to which reference will be made. The authors employed as their starting material mild steel plate 0·125 in. thick, containing 0·10 to 0·13 per cent. of carbon and the usual amounts of commercial impurities. The sheets were covered with a thin layer of scale which had to be removed by pickling in dilute sulphuric acid, leaving a dull metallic surface free from serious defects. The test-pieces used were from 8 to 12 in. in length by 1 to 2 in. in width. Chappell's earlier work having shown that the presence of carbon in iron restricts the size of the crystals which could be developed, and the authors' investigations of the defective stampings having shown that coarse crystallisation was more pronounced where decarburisation has occurred, it was decided to remove all carbon from the test-pieces before attempting to produce large crystals. It was necessary to determine carefully the conditions of decarburisation, since the problem resolved itself into obtaining an iron of suitable crystal size free from carbon. As the result of a large number of experiments, it was found that a grain size of approximately 120 grains per square millimetre is required. This was obtained by decarburising at a temperature of 950° C. for 48 hours (*i.e.* in the γ range), followed by slow annealing (12 hours from 950° to 100° C.). The complete removal of carbon was found to be necessary. From this material large crystal test-pieces could be prepared by an elongation of 3·25 per cent. produced by tensile stress, followed by annealing just below the A_3 change point (about 880° C.) for three days. The maximum size obtained was 4 in. × 1¼ in. × ⅛ in.

A complication from which aluminium is free is the presence of a surface film of very fine crystals which masks the very large crystals produced, and in order to reveal them it is necessary to remove this layer. The authors' experiments show that in general this film was just one crystal thick, and they concluded that those crystals in the original material which had a "free boundary" did not undergo the same kind of change during deformation by tensile strain as the interior crystals. They found, however, that if the elongation was produced by rolling, the surface film of fine crystals was not produced after annealing.

Tensile tests were carried out on test-pieces cut from strips containing large crystals, so that the parallel portion in each case was occupied by a single crystal. Values of from 9 to 10 tons per square inch ultimate stress and 30-50 per cent. elongation on 2 inches were obtained, and may be compared with about 19 tons per square inch and 53 per cent. elongation obtained for the same material in the fine-grained condition. A single crystal cut from the coarsely crystalline strip can be rolled out to 100 times its original length and reduced from 0·125 to 0·001 in. without annealing and without showing any signs of cracking at the edges. The properties in this respect were very similar to those of the aluminium crystals made and tested by Carpenter and Elam. It was found, however, that in certain circumstances these large iron crystals were exceedingly brittle, a property not hitherto observed with aluminium. If a crystal were placed in a vice in a certain way and given a sharp blow with a hammer, fracture frequently occurred along what appeared to be a cleavage plane. A large number of crystals were broken in this way. Only in a few cases did bending occur, such as would happen in finely crystalline iron. In the large majority of crystals tested it was found possible to obtain fractures in two planes exactly at right angles. The authors consider it probable that the large crystals grown in strained iron possess a similar orientation.

Messrs. Edwards and Pfeil have established two important facts which bear on the production of large iron crystals: (1) The critical strain required to produce very large crystal-growth on subsequent annealing varies with the initial grain size of the material used, the larger the grain size the greater being the strain required. With very large crystals, sufficient strain to cause growth cannot be applied, since recrystallisation occurs at the crystal boundaries. (2) Surface crystals of the original finely crystalline aggregate behave differently from those in the interior and require a greater tensile strain before they will disappear.

The authors explain these facts in the following way. In the case of a single crystal it is considered that deformation occurs by a process of slip causing little change in the crystal lattice. Some change must occur, for single crystals of tungsten, aluminium, and iron are hardened by cold work, but in the case of single iron crystals, whatever change up to 25 per cent. elongation occurs is removed on annealing without producing recrystallisation. If, however, two crystals in contact are deformed, there will be interference with slip, owing to the change in the direction of the slip planes in passing from one crystal to the other. In these circumstances some other kind of movement must occur during deformation. X-ray analysis does not indicate any difference between the lattice constants of cold worked and annealed metals, but shows a relation in the former between the direction of the crystallographic axes and that of straining.

The second type of deformation is interpreted therefore as a rotation of the crystallographic axes accompanied by elastic strain. The depth to which this change penetrates from the boundaries depends upon the degree of deformation. With small crystals but little deformation will cause the depth to correspond with the radius of the crystals. The larger the crystals the greater the deformation necessary to cause the change to reach the centres. When this second type of deformation has penetrated to the centres (and the strain at the crystal boundaries has not exceeded a certain value) the authors consider that the degree of axial alignment due to rotation has proceeded to such an extent that, on annealing, it is easier for the atoms to form a single crystal than to revert to their original orientations. With very large crystals, however, before the second type of deformation has penetrated to the centres, the strain set up at and near the crystal boundaries has become so great that, on annealing, the atoms in these highly strained regions preferably form new crystals, *i.e.* recrystallise.

With regard to the small surface crystals, the authors consider that a greater degree of deformation produced by tensile stress is required before the change is sufficiently complete to permit of growth or absorption during annealing. When, however, the critical degree of strain is caused by rolling and the freedom of the surface crystals is thus at least partly removed, their growth or absorption can occur.

H. C. H. C.

Immigrant Cultures in Egypt.

By Sir FLINDERS PETRIE, F.R.S.

A GENERATION ago our view of Egypt was limited to three brilliant periods, without beginnings or connexions. The discovery of the predynastic ages in 1895 showed two successive civilisations, waxing and waning, which were disentangled by the classification of sequence-dating, and appear to have come in first from the west and then from the east. The further discovery of the royal tombs of the earliest dynasties at Abydos provided a monumental basis for what had, so far, only been recorded history. There the position has rested for twenty years, but recently much more has come to light, consolidating the long view of the past.

On a jasper cylinder seal of Asiatic work, the figure of a king named Khandy was identified with the same name recorded in the VIIIth dynasty of Egypt. As that king is shown receiving homage from a Syrian, and secondarily from an Egyptian, it appears that he was ruling in Syria and holding Egypt. Other foreign names in that dynasty indicate that the VIIth and VIIIth dynasties, who succeeded the first pyramid age, were Syrian rulers. This accords with the frequent use then of button badges, always of foreign work, and bearing designs known in Babylonia and Cilicia. Excavation of the cemetery of the IXth and Xth dynasties capital, Herakleopolis, showed an entire absence of the Syrian buttons, and a throw-back on to Egyptian lines, apparently due to a Libyan immigration.

Last winter the study of the rock tombs of the Uah-ka princes of Qau—south of Assyut—of the IXth and Xth dynasties, has opened a fresh view. It had already been noted that certain black granite sphinxes from Upper Egypt, which resembled the kings of the XIIth dynasty, were markedly of the Galla type. At

Qau, the temple-tombs cut in the rock are of exactly the plan of the Nubian temples, a form unknown elsewhere; and, further, the family name—Senusert—of the XIIth dynasty appears. These facts link together and agree with the Egyptian "prophecy" of the XIIth dynasty, that a king Ameny (=Amenemhat) should arise from the south, the son of a Nubian woman. It appears, then, that when the Syrians broke in on the north, the Gallas pushed down from the south, controlled the artists in black granite, and founded a rule of the south which centred at Qau; this was in alliance with the Herakleopolite dynasties, and eventually founded the XIIth dynasty at Thebes.

Last year there came to light some work of a prehistoric culture, differing in all respects from the recognised prehistoric Egyptian. This year the clearance of a stratified deposit showed that this unknown culture was as old, or older, than the early prehistoric age already recognised. As the known prehistoric culture is quite continuous on all sites, and bears nothing like the new material, the presumption is that we are handling remains of a still earlier period. This new culture is identical in the types of flint chipping with the flints so widely spread from the Fayum up to the Palestine desert. We have now certainly the general products of this people, who have as yet only been known by their flint work. Further, this work is closely like that of the lowest stages of Susa, and the Solutrean of Europe. All of these seem to be due to various waves of one Asiatic culture, and thus accord with the recent views in the "Cambridge Ancient History." The peculiarities of this earliest known culture in Egypt are: in flint, the swallow-tail arrowhead, delicate *vesica* tools pointed at both ends; in pottery, the thinnest and hardest ware known, polished black, with the surface streaked by comb-dressing all over; in beads, glazed steatite, garnet, and carnelian; in painting, the use of long rectangular palettes, concave at the ends, with green malachite, and red hæmatite face-paint. All of these may be seen in the exhibition of the British School in Egypt at University College, Gower Street, open on July 5-26. There will also be shown more remains of the earliest human period known in Egypt, from the gravels of the eastern desert; after further study, it is hoped to give some account of these.

Obituary.

CHARLES OBERTHÜR.

BY the death, at the age of seventy-eight, at Rennes of the veteran naturalist, Charles Oberthür, workers in the study of insect life have suffered the loss of one whom personal tastes, the circumstances of life, and a persevering and enthusiastic character combined to make a conspicuous and leading figure among the fraternity of entomologists. As the printer and producer of his own works, Oberthür was able to give full scope to his conception of the requirements of entomological description and illustration. Similar ideals have presented themselves to others, but to few indeed has the opportunity been given to carry them out on so extensive and magnificent a scale. The splendid series of "Études d'Entomologie" and of "Lépidoptérologie Comparée" which emanated from his press at Rennes bear witness to his indefatigable labours in the advancement of his favourite pursuit, and to the liberal, one might even say the lavish, expenditure which he devoted to the worthy presentation of the results of his entomological studies. The beauty and accuracy of the hand-painted illustrations in these volumes have never been surpassed.

Though the order of Lepidoptera engaged most of his attention, Oberthür did much to further the subject of economic entomology, which he rightly recognised as being of high importance to an agricultural community such as that of the greater part of France. The material accumulated by him is of the greatest service to students of bionomics; but to Oberthür himself the various topics offered by evolutionary problems, such as those of protective resemblance, mimicry, phylogeny and distribution, made little or no appeal; nor did he concern himself with experimental investigation of the phenomena of heredity. But in his own line, and in the working out of his own methods, he was exceptionally efficient. Many have had occasion to be grateful for his kindly and helpful generosity.

PROF. FILIP POČTA.

WITHIN the past few months death has taken heavy toll among the professors of the Charles' (Bohemian) University of Prague. On January 7 died Prof. Počta, professor of palæontology and geology. He was born in Prague in 1859 and studied first in our University, then in Bonn, in the Musée d'Histoire naturelle in Paris, in the Lavalle Museum in France, and from there in Stockholm with Prof. Lindström. His first big work was a modern investigation of the sponges from the Bohemian calcareous formation, of which he studied not only the external form but also the interior skeleton, and this study he extended to sponges from Hungary, Dresden, France, and from the collection of the Bonn University. After this he studied the rudists and worked in the Sorbonne, the École de Mines in Paris, as well as in the British Museum. After the death of Prof. Novák he investigated the material which was left by Barrande, who intended to describe it in the eighth volume of his classical work, "Système silurien du centre de la Bohême." For this purpose Počta made a great collection of illustrations of corals and Cœlenterata, a collection which was, as regards execution, without a rival. He also deciphered for the first time the inner structure of the end chamber of Orthoceras. The first part of the eighth volume was published in 1894 and the second in 1902. Being originally a palæontologist, he became later on a geologist. He published much in both sciences in Bohemian, German, French, and Magyár. Počta was a member of the Royal Society of Bohemia, of the Bohemian Academy of Sciences, of the Geological Societies of Paris, Berlin, and of other learned societies. BOHUSLAV BRAUNER.

WE regret to announce the following deaths:

Dr. George Little, state geologist of Mississippi, 1868–72, and of Georgia, 1874–81, on May 15, aged eighty-six.

Prof. Charles Hunter Stewart, professor of public health, University of Edinburgh, on June 30, aged sixty-nine.

Current Topics and Events.

THE history of the discovery of insulin occupies an almost unique place in the scientific literature of recent times, and in the supplement which accompanies this issue we print an account of the present position of investigations regarding this substance. So many investigators had previously been within an ace of making its discovery that, as Prof. MacLean says, "it still remains a mystery why insulin was not isolated many years ago." The discovery is a good illustration of two salient facts bearing on scientific research work: first, that a very slight modification of a technique which had led previous explorers to failure might lead one to success; secondly, that research work of an applied nature, such as the search for a cure for diabetes, is very closely dependent upon related investigations which belong more properly to the domain of academic science—in this instance the improvement of methods for the accurate determination of small quantities of glucose in the blood. Insulin as now placed on the market is a therapeutically trustworthy preparation, and there must be many persons who owe life and health to the careful administration of this substance. But we must not be too sanguine that a diabetic taking insulin is to be regarded as a normal person. Prof. MacLean's article also contains a warning which it is to be hoped will be taken seriously to heart: careful investigation has shown that no beneficial results ensue from taking any pancreas preparation by the mouth, and this also applies to insulin itself, which is speedily destroyed by the juices present in the alimentary canal. From the academic point of view, insulin presents many problems of absorbing interest. At present the chief of these is the problem of what happens to the blood sugar and to glycogen after the administration of insulin: both apparently disappear, yet no intermediary or end products have yet been traced. Lastly, it cannot be too strongly emphasised that the discovery, from start to finish, could not have been made without those experiments on living dogs which some would seek to have abolished.

WHY it should have been left to Sir Douglas McGarel Hogg, Sir William Bull, and Sir Malcolm Macnachten to bring in "a Bill to confer certain powers on the Trustees of the British Museum," we have been unable to ascertain; nor can we discover whether the idea arose in the minds of those gentlemen spontaneously, or whether the seed was sown by some such body as the Museums Association. The Bill is, in brief, to empower the Trustees, under certain conditions, to lend for public exhibition in any gallery or museum controlled by a public authority in Great Britain, specimens falling under the graphic arts, jewelry, and "objects of art in gold, silver, bronze or crystal,"—a sufficiently curious selection. It proposes, therefore, an extension of the openings already made in the foundation Act of 26 George II., by which all objects entering the Museum were to "remain . . . to all Posterity." The Trustees have already obtained power to exchange, sell, or dispose of (7 & 47 George III.), as also to give away (41 & 42 Vict.), duplicate objects "not required for the purposes of the Museum"; but they have not as yet the power to lend. We do not know that they want it. If they are given it, we may rely on them to exercise it with due discretion. The British Museum is a storehouse to which there come by thousands inquirers from the uttermost ends of the earth. Such a student must not arrive in London to find that, of the objects he wishes to compare, one has been sent to Aberdeen and another to Penzance. There can never be any advantage in encouraging the British Museum to emulate the admirable Circulating Department of the Victoria and Albert Museum.

IN the *Times* of June 26 there was a somewhat sensational paragraph entitled "New anti-tuberculosis vaccine." It was stated that Prof. Calmette of the Pasteur Institute had, with various collaborators, discovered a new tuberculosis preventive. The further contents of the paragraph show that in its essence the discovery is not altogether new and has in part, at any rate, been referred to on more than one occasion, and most recently in the Annales de l'Institut Pasteur (xxxviii., 1924, p. 371). Calmette's vaccine is a living culture of tubercle bacilli which has been grown on a potato medium containing bile and glycerin for thirteen years. During this period it has become avirulent and is incapable of producing tuberculosis. It is claimed, however, that it is capable of establishing an immunity against virulent tubercle bacilli, and particularly so when injected into calves shortly after birth. The protection afforded by the avirulent bacilli lasts for more than a year. It is believed that the same results may be obtained in infants, and some work in this direction is briefly referred to in the *Times* paragraph.

IN NATURE of May 10, p. 685, we published a note on the alleged discovery of the long-sought virus of foot-and-mouth disease by Profs. Frosch and Dahmen of Berlin. From the reputation of these workers and their statement of experiments we were inclined to regard the discovery as correct, and this now appears to be so. In an article in the *Lancet* of June 28 considerable details are given of a lecture delivered by Dahmen and Frosch at Utrecht, and it is therein stated that a committee of six experts, including such well-known investigators as Titze, Giese, Kleine, and Gins, have been able to confirm the statements of Frosch and Dahmen, and that with subcultures of the virus in the sixth and twenty-sixth generation they had succeeded in reproducing the disease. On the assumption that the virus of foot-and-mouth disease has been discovered, it has been assumed by some that a royal road has been opened up for the prevention of the disease, but it is perhaps scarcely necessary to point out that this is not a corollary, for the establishment of immunity may not take place in spite of the presence of the virus.

THE annual conversazione of the Institution of Electrical Engineers held at the Natural History Museum, South Kensington, on Thursday, June 26,

was one of the most notable of a long series of annual functions in pleasant surroundings, due to the fact that it was held on the hundredth anniversary of the birth of Lord Kelvin, and formed a part of the group of centenary celebrations being held this summer in scientific and engineering circles, and to include, as we have already announced, the Kelvin Centenary Oration by Sir J. J. Thomson on July 10 and the Kelvin Centenary Banquet on the following day. A large company was received by the president, Dr. Alexander Russell, and Mrs. Russell and members of the Council of the Institution, and an excellent programme of vocal and instrumental music, in which Miss Phyllis Carey Foster took part, was provided in the Reptile Gallery, while the string band of the Royal Engineers performed in the Central Hall. Many distinguished engineers were present, and there must have been many there who remembered Lord Kelvin's regular attendance at these conversaziones in his later years.

IT is of interest at the present time to recall that Lord Kelvin, Sir George Stokes, and Prof. Huxley were elected fellows of the Royal Society in the same year and on the same day, namely, June 5, 1851. Each of this brilliant triumvirate lived to receive the honour of the presidency, in 1883, 1885, and 1890 respectively. The certificate of candidature of Lord Kelvin (William Thomson) was signed by Michael Faraday, John Couch Adams, and Adam Sedgwick, the distinguished Woodwardian professor of geology in the University of Cambridge. In retrospect, the support of Sedgwick is especially interesting since we know, through Sir Archibald Geikie, that from the year 1844 onwards for some eighteen years Lord Kelvin watched with increasing impatience the spread of the doctrines of the Uniformitarian School in geology, and at length, in 1862, "broke silence on the subject, declaring the doctrines of that school to be opposed to physical laws." It was one of the accepted tenets of the Uniformitarian School that the range of past time available for the explanation of the phenomena of geology was unlimited; but by arguments drawn from the origin and age of the sun's heat, the internal heat and rate of cooling of the earth, and the tidal retardation of the earth's rotation, Lord Kelvin fixed limits to the possible age of our planet. These have, of course, more recently been disputed. Lord Kelvin was always most punctilious in correspondence. Following the onerous engagements incidental to the celebration of his professional jubilee at Glasgow in 1896, he occupied himself on the way to London in writing autograph acknowledgments of the congratulation of friends. Not a few of his distinctive shorter papers were composed during railway journeys between Glasgow and London. In fact, wherever there was motion he found an atmosphere of calm, the hum of machinery acting as a mental stimulus. Mention may be made here that Lord Kelvin's portrait, by Orchardson, hangs in the Royal Society's meeting-room, the gift of a circle of fellows.

A TORNADO of hurricane strength swept over a fifty-mile stretch of the southern shore of Lake Erie in the afternoon of Saturday, June 28. According to the correspondent of the *Times*, three hundred persons are believed to have perished at Lorain, and the number of persons injured in the devastated track is estimated to be 2500. Many buildings are completely wrecked at Lorain, and in parts of the town it is reported that not a house was left standing. The principal destruction and damage occurred between Sandusky and Cleveland, and fear is entertained for some small passenger steamers plying on the Lake. The report states that the full extent of the damage will not be known for days. Earlier in the day, much havoc is said to have been caused by storms in the Upper Mississippi Valley. At Peoria, Illinois, hundreds of houses were unroofed and damage is reported from other places. The U.S. Weather Bureau will without doubt give details of the tornado. In the past, many such storms have been dealt with, notably by Finley and Ferrel.

IN view of some criticisms that have been made in Canada concerning Dr. V. Stefansson's recent geographical discoveries in the Arctic, attention may be directed to an article in the *Geographical Journal* for June. The Royal Geographical Society, on receiving from Mr. J. White, technical adviser to the Ministry of Justice, a detailed statement of the criticisms, submitted these to a searching examination by an impartial authority. All relevant original documents were consulted, including blue books of the various Franklin search expeditions, Sverdrup's charts of the adjoining regions, and Dr. Stefansson's own charts. A lengthy reply to Mr. White's letter, illustrated with charts, is published. Each point is examined in great detail, and the conclusions reached may be taken as final. They completely exonerate Dr. Stefansson of the charges that his discoveries of new land were anticipated by previous explorers, with the sole exception that Lougheed Island may have been sighted by Richards in 1853, but there was no suggestion of a land mass of the size of the island charted by Dr. Stefansson. The extensive islands now called Brock and Borden Islands were never suspected to exist. The Royal Geographical Society has done a service to polar exploration in disposing of these criticisms and establishing the validity of Dr. Stefansson's claims.

IN our issue of June 16, 1923, p. 818, reference was made to the formation of a committee to collect funds in order to commemorate the late Prof. A. D. Waller and Mrs. Waller. We understand that the fund has now reached a total of 1820*l.* and that a meeting of subscribers, probably a final one, will be held on July 5 at 5 P.M. at the London (R.F.H.) School of Medicine for Women. It will be remembered that the fund is to be used for the promotion of scientific research and is to be administered by the council of the London (R.F.H.) School of Medicine, with which Prof. Waller and Mrs. Waller were associated for many years. It is hoped that the fund will reach 2000*l.* by the time of the meeting on July 5, and that it will then be possible to discuss the final form of the memorial.

THE staff of the Bombay Department of Agriculture interested in research into botanical and genetical problems has grown very considerably of recent years, and on April 14-16 the plant breeders of the Department held a conference in the Botanical Laboratories of the College of Agriculture, Poona, under the presidency of Dr. W. Burns, Economic Botanist to the Government of Bombay. An introductory address by Dr. H. H. Mann emphasised the need of attacking problems of economic interest in a truly scientific manner, and the subsequent proceedings of the conference, when methods of testing the performance of varieties of crop plants of economic importance were rigorously examined in the light of modern knowledge of statistical, botanical, and agricultural technique, suggest that Dr. Mann was preaching to the converted. Some forty specialists gathered at the conference, which was convened at short notice; they were drawn from the fifteen workers in the Government Plant-breeding Department, the five men working under the Sassoon David Trust, the Indian Cotton Committee investigators, and the staffs of the Economic Botanist and the Horticulturist. The conference also utilised the occasion to examine the experimental and demonstration plots conducted by the Poona College of Agriculture, of which Dr. Burns is Principal. At the close the conference recommended to the Director of Agriculture that such a conference should be held annually, and that next year it should meet in Surat.

THE influence of Joseph Leidy on science forms the subject of three interesting addresses delivered in December last at the Academy of Natural Science of Philadelphia and published in the *Scientific Monthly*, April 1924. The veteran Dr. Edward S. Morse said that in the midst of the rush for the description of new species, Leidy pursued his researches on the habits and anatomical details of creatures ranging from the protozoa to mammals, and his profound knowledge of the osteology of mammals enabled him to lay with a master hand the foundation for the palæontology of the reptiles and mammals of North America. Nearly a third of his published memoirs, extending over a period of forty years (1848–88), are on this subject. Prof. W. B. Scott reminded his audience that Leidy throughout his life was primarily interested in human anatomy and that he remained, almost to his death, professor of human anatomy in the Medical School of the University of Pennsylvania. Prof. Scott paid generous tribute to the value of Leidy's work in palæontology and geology. He stated that Leidy was the first to show that there were native horses and rhinoceroses in America, and he also found the first American camel. Prof. H. S. Jennings pointed out that Leidy seems to have attempted and carried out to a remarkable degree of success the project of forming for himself, and communicating partly to others, a detailed picture of the living world in relation to the environment. He was the better enabled to do this because of his artistic aptitude; indeed his work is largely a portrayal of Nature as seen by a thorough scientific artist, of which his great memoir on the fresh-water rhizopods is an outstanding example.

WE learn from *Science* that Prof. J. C. McLennan, of the University of Toronto, has been elected president of the Royal Society of Canada.

THE Agricultural and Horticultural Research Station of the University of Bristol will be open to visitors on July 15, when the experimental work in progress will be demonstrated by the staff.

MR. E. E. AUSTEN has been appointed deputy keeper in the Department of Entomology of the British Museum (Natural History), South Kensington.

THE Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts was incorporated on March 30, 1824. The centenary, therefore, falls due this year, and will be celebrated on September 17-19.

APPLICATIONS are invited for two assistantships at the Solar Observatory of the Commonwealth of Australia. They should be sent to reach the High Commissioner for Australia, Australia House, Strand, W.C.2, by, at latest, July 31. Further particulars are obtainable upon request.

MR. E. R. D. MACLAGAN has been appointed by the President of the Board of Education to succeed Sir Cecil Harcourt Smith, who will retire from the position of Director and Secretary of the Victoria and Albert Museum in September next. Mr. Maclagan has been deputy keeper of the Department of Architecture and Sculpture in the Museum since 1921.

THE Imperial Botanical Conference opens at the Imperial College of Science and Technology, South Kensington, on July 7, under the presidency of Sir David Prain. A large number of overseas and British botanists have signified their intention of attending the Conference, for which an attractive programme has been arranged.

THE Safety in Mines Research Board is in need of the services of a number of abstractors—men or women—able to make rapid and accurate translations (abstract or full) from German and French scientific publications. Applications for the posts, giving full particulars of qualifications, etc., should be addressed to the Under Secretary for Mines, Mines Department, Dean Stanley Street, S.W.1, not later than July 19.

A GOVERNMENT chemist is required for service in Fiji, largely in connexion with the agricultural department. Candidates should, if possible, be University graduates; they must be associates and fellows of the Institute of Chemistry, and have had experience of the work of a public analyst. Requests for forms of application and for further particulars should be addressed in writing to the Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1.

A DECIMAL-METRIC Conference has been arranged by the Decimal Association and will be held on July 9 in the house of the Institution of Electrical Engineers. The subjects to be discussed are decimal coinage,

with special reference to the ten-penny shilling, and piecemeal proposals for introducing metric weights and measures. Among the speakers will be Sir Robert Horne, Sir Robert Hadfield, Sir Napier Shaw, Mr. Harold Cox, Mr. Gordon Selfridge and Mr. Felix Blakemore. A number of chambers of commerce and other public bodies in the Dominions Overseas are sending delegates, and representatives from the United States will also be present. In connexion with the Conference a visit to the National Physical Laboratory, Teddington, has been arranged for July 10.

AT a meeting of the Botanical Society of Edinburgh, to be held at the Royal Botanic Garden, Edinburgh, on July 17 and 18, demonstrations and communications on various aspects of vegetative plant propagation are to be given. At the morning sessions of the meeting, numerous illustrations of the methods and results of propagation from stem, leaf, and root, will be presented, while the afternoon sessions will be devoted to the reading of papers and to a general discussion of the exhibits. The following papers will be read: (1) The propagation of clematis, by Miss Edith Philip Smith; (2) on cuttings of camphor, by Miss Oona Reid; (3) horizontal branch propagation, and (4) root cuttings, by Mr. L. B. Stewart; (5) propagation by bulb scales, by Dr. R. J. D. Graham.

THE Egyptian Government Almanac for 1924 (Cairo: Government Publications Office, 1924; price 10 P.T.) maintains the high standard of usefulness of former editions. It contains a good deal of statistical matter, but aims rather at being explanatory and descriptive. Matters of scientific interest include some papers on the geographical features of Egypt and a useful article on the Nile, its tributaries and water supply. There are notes on the survey of Egypt, the antiquities department and the physical department, including a summary of meteorological data. The section on agriculture and industries is particularly full.

MESSRS. H. SOTHERAN AND CO., 140 Strand, W.C.2, and 43 Piccadilly, W.1, have just issued No. 789 of their "Price Current of Literature," being No. 3, Pt. 4, of their "Catalogue of Science and Technology," and comprising the titles and bibliographic details of some hundreds of books relating to physics, many of which are rare and of great interest and importance. A valuable list of works by, and respecting, Sir Isaac Newton is included. The catalogue should appeal to all students of physics.

ERRATUM.—In announcing the award of a Research Prize of 1000 dollars to Dr. Mary Evelyn Laing in NATURE of June 28, p. 935, it should have been stated that the award referred to is the Ellen Richards Research Prize for 1924.

Our Astronomical Column.

EYEPIECES USED BY SIR WILLIAM HERSCHEL.—It is well known that Sir William Herschel stated that at times he used eyepieces giving magnifying powers in the neighbourhood of 6000. The eyepieces themselves seem to have been lost sight of after his death, and considerable scepticism as to the reality of these powers was expressed by subsequent writers. But recently, Dr. W. H. Steavenson, who was making by request a thorough examination of the Herschel instruments at Slough, found the eyepieces in question, and measured their powers with a dynamometer. He found values agreeing within 10 per cent. of those stated by Herschel, the highest power being well over 6000. This was naturally a single lens, $\frac{1}{60}$ inch in diameter. From a highly enlarged photograph the lens was seen to be not a natural spherical drop, but carefully figured. The curves were hyperbolæ rather than circles, and the two sides were not quite symmetrical, but Dr. Steavenson found that he could get fair definition on a portion of Saturn: the diameter of the well-defined region was only 26″, so that it must have been excessively difficult to keep objects in the field without equatorial mounting. It is satisfactory that Sir William Herschel's accuracy of statement is once more vindicated.

MINOR PLANETS.—The observation of these bodies, which was greatly interrupted by the War, is now once more in full swing. Several interesting objects have been detected in recent months. *Astr. Nach.* No. 5293 contains a study of the special perturbations by Jupiter and Mars of 132 Aethra, by Mr. C. J. Merfield, of Melbourne Observatory. He gives osculating elements for the oppositions of 1924, 1925, 1926, together with an accurate ephemeris for the next few weeks. This body was found by Watson in 1873, and was then lost for fifty years, being recovered in December 1922.

Astr. Nach. No. 5292 contains some observations of Eros made at Berlin-Babelsberg last autumn, its magnitude being 9·6. The planet afterwards went southward, and its observation was continued at Johannesburg. Dr. Witt, its discoverer, is engaged on a careful study of its perturbations, in order to predict the conditions of its near approach to the earth in January 1931. These recent observations will be very useful, as the planet was fairly near the earth.

The last assignment of numbers to recently discovered planets extended to No. 995. As many have been discovered since, the next numbering, in a few months' time, will undoubtedly extend beyond 1000. It should be noted that the number of those known to exist, but not all observed sufficiently for definite numeration, passed 1000 several years ago.

REPORT OF THE CAPE OBSERVATORY.—Dr. H. Spencer Jones, recently appointed H.M. Astronomer at the Cape, has just issued his first annual report. Besides the usual meridian observations, heliometer comparisons of the major planets with neighbouring stars are being made regularly. These have a considerably smaller probable error than meridian places, so will ultimately be very useful for improving the tables of these bodies.

Stellar spectrographs have been taken with the Victoria telescope for the measurement of radial velocities. Many plates have also been taken for proper motions both with this telescope and the astrographic: they are examined by Dr. Innes with the blink micrometer. Messrs. Long and Skjellerup, two voluntary observers, used the small equatorials for the study of 60 variable stars, obtaining more than 140 observations.

Dr. Halm is continuing his studies on stellar masses and luminosities. He suspects that the masses are grouped round the values 6·5, 3·3, 1·6, 0·8, in terms of the sun; they appear to form a geometrical progression. Further details are promised shortly.

Wireless time-signals for the use of ships are sent from the Observatory to Slangkop, where they are automatically distributed.

Research Items.

POPULATION AND ENVIRONMENT.—Dr. S. M. Shirokogoroff has published, through Messrs. Edward Evans and Sons of Shanghai, under the title "Ethnical Unit and Milieu," a valuable study of population problems, in which he lays down a number of propositions supported by examples drawn mainly from his studies of the peoples of north-eastern Asia. In a community, if an increase of population exceeds the possibility of nourishment, the excess of population must perish or the natality must be regulated by some means, medical, artificial, social, etc. Increase of population is regulated by the extent of territory and by the growth of culture; the more intensive the exploitation of territory, the larger the population it may nourish, as, for example, in an agricultural as contrasted with a hunting community. Maintenance of the level of numerical value must be understood relatively to the variation of culture and territory, a conclusion which has a direct bearing upon the question of degeneracy and decline of any given people. Variation of some aspects of the cultural complex is followed by variation in the whole complex and entails a period of cultural disequilibrium. Physical degeneracy may be either a process of extinction or a substitution of one anthropological type for another; in both cases there is an ethnical disequilibrium. Limitations being imposed upon the possibility of variation in the factors of culture, territory and density of population, which are interdependent, the general conclusion follows that there will be a degeneration or decline and an end of the present species of man. It is probable that the greater part of the way to absolute density of population is already covered, and that mankind is at present near its culmination.

THE MOTHER GODDESS IN EGYPT.—In No. 11 of the Journal of the Manchester Egyptian and Oriental Society, Mr. John Lewis analyses certain forms of Egyptian belief with the view of showing that they point to conceptions associated with the cult of a Great Mother Goddess such as Prof. Elliot Smith has postulated to lie at the root of primitive and early religion. Mr. Lewis compares the graffiti of the rocks at Gebel Hetematt, Wady Hammanat, and Selsileh, and the paintings of the prehistoric tomb near Hierakonpolis, with the cave drawings of France and Spain, and from their similarity deduces that they are based upon identical magical ideas connected with food and protection. The statues of the god Min, at one time a female deity, link up the ideas of water, the life-giving element, the shell, which is the life-giving female deity, procreation, the mother-deity and the father-deity. The girdle of Hathor-heads on the slate palette of Narmer is a development of the shell-girdle, the strength of Hathor-Isis, which connects the shell-deity with Hathor.

ORIENTAL PREHISTORY.—M. J. de Morgan contributes to *l'Anthropologie*, t. xxxiv. 1-2, the first of a series of articles on the prehistory of Western Asia and Egypt. In neolithic times, possibly from late quaternary times, it is suggested as a working hypothesis that the areas under consideration were inhabited by four races—in the north a white Caucasic race, of which traces may perhaps still be found in the remote mountain districts of the Caucasus; in the south, stretching from Elam to the Mediterranean, a negrito race related possibly on one side to peoples living in the Indian Peninsula, on the other to the inhabitants of the European caves; in Egypt and North Africa, Berbers; and Semites in Arabia. This multiplicity of races at this stage throws no light upon the question of origins. That part of Western Asia, of which the country of the Euphrates and Tigris—the cradle of civilisation—is the centre, is cut off from the rest of the world. It contains three types of geographical areas, a mountain region, plateaus, and plains. An examination of the geological conditions from early quaternary times indicates that Chaldæa, lying between mountains and plateaus with their cold and humid climates and the hot dry desert area, alone afforded conditions suited to man in early times, and this owing to the fact that it was watered by two rivers. The plateaus did not become habitable by man until he possessed domesticated animals capable of subsisting on pasture land.

ANIMAL LIFE IN DESERTS.—In the Proceedings of the Royal Society, B, vol. 96, 1924, pp. 123-131, Mr. P. A. Buxton records the results of some investigations made in Palestine on the relations of temperature and moisture to animal life in deserts. This observer finds that the soil surface commonly reaches 60° C. at midday, and certain insects are active upon it even at that temperature. Their body temperature is lower than might be expected, probably owing to loss of water during respiration. An interesting point is that the black form of a dimorphic grasshopper has a body-temperature 4-5° higher than the buff form, when exposed to the sun. If the loss of water hypothesis be correct the insect's need for water is greater than is commonly believed. Deserts have a great diurnal range of temperature and of relative humidity. The night air is often almost or quite saturated with moisture, while by day the humidity may drop to 20 per cent. It appears that the desiccated fragments of the annual vegetation are hygroscopic: that they take up a considerable proportion of water from the moist night air and hold it for several hours after the sun has risen. The author believes that this property of the dried pieces of grass and herbage is one of the foundations which support all animal life in deserts during summer. These fragments, with the moisture absorbed over night, are eaten by certain insects which in turn become a source not only of food but also of water, for the birds, lizards, predaceous insects, and other carnivorous animals.

SYMBIOSIS BETWEEN TERMITES AND THEIR INTESTINAL PROTOZOA.—L. R. Cleveland has given further details of his work on the symbiotic relationships between the intestinal protozoa of termites and their host (*Biol. Bull.*, vol. 46, pp. 177-225, 1924). The protozoa principally concerned are flagellates—Trichonympha and related forms. By incubating termites at 36° C. for 24 hours (a method due to Grassi) the flagellates are killed, but the termites are uninjured. If such "defaunated" termites are given their normal diet of wood, they eat quantities of it, but they become less active and die within three or four weeks. If "defaunated" termites are placed with ordinary ones, the former—by feeding on the fæces of the latter—become reinfected with protozoa, and after about ten days regain the ability to utilise wood and can live indefinitely. When termites were starved, the wood-ingesting protozoa in their intestine died within eight days, and the termites when returned to a wood diet lived only a few weeks. These and other examples emphasise the close correlation between the wood-feeding habit and the presence of protozoa. That the latter use the wood as food and not the intestinal fluids of their host is

proved by direct observation—numerous wood particles are present in the posterior portion of Trichonympha—and by the fact that these protozoa die ten to twenty days before their host when wood is withheld. In normal-feeding termites a large percentage of the wood which they have eaten may be found in the protozoa, and in termites starved for a few hours it is almost impossible to find any wood particles in the intestine ; they have all been ingested by the protozoa and the particles gradually disappear. A large amount of glycogen is present in these protozoa produced by digestion of the wood. The termites furnish food and lodging to the protozoa, and the latter provide products formed by digestion of the wood—a clear case of symbiosis. The young termites feed on excreta loaded with flagellates, so that they are practically certain to become infected, and then they begin to eat wood.

MASS RELATIONS OF CYTOPLASM AND NUCLEUS.—Prof. R. W. Hegner brings together (*Scientia*, June 1924) evidence from his observations on Arcella and Opalina and from those of other investigators on protozoa, in regard to the mass relations existing between cytoplasm and chromatin, and concludes that the following generalisations are reasonably established : At each stage in the life cycle of these organisms there is a fairly definite amount of cytoplasm associated with each nucleus. The size of the nucleus is an indication of the amount of chromatin contained within it ; the amount of chromatin is the real factor involved in the ratio of nucleus to cytoplasm. Nuclear division is initiated by an increase in the amount of cytoplasm as compared with that of the nucleus.

VITALITY OF POLLEN GRAINS.—Mr. S. Nohara (*Japanese Journ. of Botany*, vol. 2, No. 1) has made an experimental study of the pollen in several species and hybrids of Salix. Germination of the pollen was most successful in 2-5 per cent. sugar solution, beginning very quickly, and the pollen tubes attaining a length of 4-8μ in half an hour. Tests of the longevity of pollen showed that it was much affected by temperature, humidity, and light, and that its germinating power could be maintained for seventy days in a dry, cool, dark place. Temperatures so low as 21° below zero for 8 hours do not lessen the germinating and fertilising power, while a temperature so high as 37° kills the pollen. Chloroform vapour terminates the germinating power of pollen in 4-5 hours, and ether vapour in 20 hours. In certain hybrids between *Salix viminalis* and *S. multinervis* the pollen and seeds were nearly normal, but the catkins showed various intersexual conditions.

BOTANICAL NOTES FROM CEYLON.—The Annals of the Royal Botanic Gardens, Peradeniya, vol. viii., May 1924, is mainly contributed by Mr. I. Petch, Government Botanist and Mycologist, Ceylon. A long paper upon the insect catching proclivities of the flowers of species of Aristolochia cultivated in Ceylon includes a record of their insect visitors so far as identification of the tropical insects had proved possible. Mr. Petch concludes that the flies are attracted to the flowers by their odour, which is offensive in *A. gigas*, but in some species, such as *A. ridicula* and *A. elegans*, is not detected by man's senses. The flies then seem to enter the tube of the flower by accident, and are prevented from crawling out by the inwardly and downwardly directed hairs, until later these hairs wither. One interesting conclusion from the record of insect visitors is that the hooded type of flower, which is regarded as primitive, is the most effective in attracting and trapping insects ; the striking bizarre forms, such as *A. ringens*, attract few flies, so that " the advantage of a further evolution in the direction taken by these extraordinary forms is not obvious." Mr. Petch also describes the species of Xylariaceæ recorded for Ceylon up to the present date (pp. 119-166), and has a note upon extraordinary forms of fructification extending the range of variation recorded for Diplodiella. Mr. C. Ragunathan confirms the occurrence of teleutospores in *Hemileia vastatrix* B. and Br., the coffee leaf disease ; they were previously recorded by the late Prof. Marshall Ward, but have not been seen by subsequent investigators.

ORIGIN OF TINSTONE.—Bulletin No. 5 of the Geological Survey of Nigeria, by Mr. C. Raeburn, deals with the tinfields of Nassarawa and Ilorin Provinces (London : Crown Agents for the Colonies, 1924. 10*s*. net.) It describes two separate areas in considerable detail and discusses the origin of the tinstone, which it says " is due to pneumatolytic action on the granite and gneisses near their contact. This gives rise to greisen, usually containing topaz and tin, and carrying networks of quartz veins with tinstone, and at times to a complete replacement of the rock in the direction of topazisation or micasisation. As regards that part of the tinstone which is related to the pegmatites, it must be emphasised that it, both in point of time and manner of origin, is quite different from the other. On the one hand we have tinstone as an original constituent which had already commenced to crystallise before the intrusion of the rock ; on the other we have tinstone as a later mineral formed by pneumatolysis after the intrusion and solidification of the granite."

ZIRCONIUM AND HAFNIUM ORES.—The results of some analyses of zirconium ores by G. Hevesy and V. T. Jantzen are published in the *Chemical News* for May 30. Malacon from Madagascar and from Hitterö is particularly rich in hafnium, the former containing so much as 7 per cent. and the latter 5 per cent. of hafnium oxide. Three out of four specimens of thorteveitite showed a higher hafnium than zirconium content. The superior radioactivity of ores with a high hafnium-zirconium ratio over that of the more abundant zirconium ores is due to the presence of uranium and thorium oxides.

METEOROLOGICAL DATA OVER THE OCEANS.—From various sources the Royal Netherlands Meteorological Institute has produced some useful tables of monthly meteorological data over the oceans for the year 1921 (Bulletins 6^1 and 6^2). The computations are for ten-degree squares and give the mean force and direction of the wind, the atmospheric pressure, air and water temperature, and cloudiness. In the Atlantic Ocean the data are given between 5° to 25° N. and 25° to 45° W. and between 0° to 20° S. and 10° E. to 10° W. ; in the Indian Ocean between 10° and 20° N. from 70° to 90° E. and between 10° and 30° S. from 90° to 110° E. ; while in the Pacific Ocean the limits are 10° to 30° N. and 140° to 160° W., and 10° to 20° S. and 90° to 110° W. The observations thus leave out of account large areas of the oceans especially in high latitudes, and are not complete in many parts of the Pacific Ocean within the limits given. But they can of course be obtained only on frequented trade routes. The number of observations in each month varies in different squares from one to more than a hundred. The corresponding data for 1917–1920 consisting only of Dutch observations are promised shortly.

FREE-AIR TEMPERATURES AND WIND DIRECTIONS.—The *Monthly Weather Review* for January, published by the U.S. Weather Bureau, has an article by Mr. W. R. Gregg showing the relations between the above.

The purpose of the discussion is to utilise, for the advancement of the subject, the available free-air observations made in the United States from 1915 to the present time. All observations made with kites are considered, but the discussion is chiefly confined to data from Drexel, Nebr., and Ellendale, N. Dak. Observations of wind and temperature are grouped for 16 points of the compass for the surface, and for one, two, three, and four thousand metres above sea-level for each station, also for spring, summer, autumn, winter, and the year. The observations with N.N.W. to N.N.E. and S.S.E. to S.S.W., with distinctly north and south components, are separately combined for each elevation. At all levels to at least 4 kilometres much higher temperatures prevail with south component than with north component surface winds. Differences are smallest in summer, averaging about 5° C. The differences are greatest at 1 and 2 kilometres, but at 4 kilometres they average 7° to 8° C. It is pointed out that the free-air position of a low barometrical centre is usually to the north-west of the sea-level position, and that of a high to the south-west, so that winds are south-westerly above the sea-level positions of lows and north-westerly above the sea-level positions of highs, and consequently the air above lows is warmer than that above highs. Taking the lowest and highest pressures at different heights as the basis of comparison, it is found that the lowest pressures are accompanied by the lowest temperatures, the pressure itself at any level being largely a function of the mean temperature of the air column beneath. Numerous examples and charts are given, showing the influence of the source of air supply on the changes of temperature experienced during the passage of areas of low and high barometer. The discussion is of great value to experimental meteorology.

ADSORPTION.—Since Gibbs deduced an equation for the change of concentration of a dissolved substance at the surface of separation of its solution from another material, in terms of the rate of change of surface energy with concentration, attempts have been made to test its validity by experiment. The most successful experiments up to the present were those of Donnan and Barker in 1911. J. H. Mathews and A. J. Stamm, in the May number of the Journal of the American Chemical Society, describe experiments at a liquid-liquid interface, using a drop-weight method. Solutions of dimethylaniline in heptane and in benzene were used. The qualitative results confirmed Gibbs' formula, and by calculation from the quantitative results Langmuir's theory of adsorption was found to be verified, namely, the adsorption is one molecule thick up to concentrations where a complete surface layer is formed. The molecular thicknesses and cross-sections agree with those of other investigators.

APPARENT SELECTIVE REFLECTION OF X-RAYS BY CRYSTALS.—Dr. W. Kossel, in the *Zeitschrift für Physik* for May, deals with the observations of Clark and Duane, which these authors have interpreted as indicating selective reflection. Kossel points out that, according to the ideas of the mechanism of radiation held up to the present, a coherence between the radiation of separate atoms, such as is required to explain selective reflection, is not to be expected, since the times during which they are excited are supposed to be irregularly distributed. He finds it possible to explain a good deal of the experimental material of Clark and Duane, in part quantitatively, by considering the variations of the absorption coefficient of the crystal. X-rays of wave lengths for which the coefficient of absorption is small penetrate to a greater depth into the crystal than those for which it is large, and stronger interference effects are produced by the crystal lattice with the first than with the second. It seems doubtful whether any new phenomenon, which can be described as selective reflection, is involved.

MAGNETON NUMBERS AND ATOMIC STRUCTURE.—It is interesting to note that a certain amount of scientific work is still being carried out in Russia. Dr. J. Dorfmann contributes a paper, dated from Leningrad, to the May issue of the *Zeitschrift für Physik*, in which he puts forward a series of hypotheses as to the relation between the electron orbits of the elements, and their magnetic properties. Bohr has shown that atoms with a closed electronic configuration, where the orbit groups contain 2, 4, 6, 8 similar n_k orbits, are diamagnetic; and that paramagnetism appears when they contain 1, 3, 5, 7 orbits. If there is only one electron in an orbit group, the magnetic moment due to it is given in Bohr units, by the k number of the orbit; the author assumes that, with a group having 3, 5, 7 or $2p+1$ orbits, $2p$ of them form a symmetrical diamagnetic complex, while one of them takes part in the paramagnetism, and contributes a moment of k units to the atom. The moments due to different asymmetrical orbit groups are supposed to add, when the principal quantum number n is the same for all the groups concerned; while for different values of n they are regarded as combining vectorially. Orbit configurations have been worked out for different ions of the elements between scandium and zinc; and values of the magnetic moments have been calculated, on the above assumptions, which agree quite well with the observed values. A similar table is given for the elements from lanthanum to hafnium, for which, however, the observational data are not quite complete.

STEAM-NOZZLES.—The third report of the Steam-Nozzles Research Committee has now been presented to the Institution of Mechanical Engineers, and comprises (*a*) tests on convergent impulse nozzles, 20° nominal angle, with thick partition plates; (*b*) a series of tests to determine the effect of chamfer on the exit edges of comparatively thick plates; (*c*) work on the $\frac{3}{8}$-inch Parsons standard 430 B blades, which emphasises the effect of entry on nozzle efficiency; (*d*) the first test results of a set of straight elementary nozzles designed by Prof. A. L. Mellanby. The general shape of the curves obtained for the velocity coefficients of steam-nozzles (given in the second report) has been corroborated, and in one or two cases the curve has been carried sufficiently far into the low velocity region to indicate that it "turns over" as predicted by Mr. Martin. The effect of chamfering thick plates of convergent nozzles is clearly shown in the present report; it would appear that a thick plate nozzle with a chamfered exit can be made as efficient, over a considerable working range, as a nozzle with very thin plates. A straight elementary nozzle is in general 5 per cent. more efficient than the practical types of nozzles which have been tested. A review of both second and third reports goes to show that the condition of entry or of exit is important; the steam should approach the nozzle as smoothly and as slowly as possible, and no flat surfaces should be left on the exit side of any nozzle. There are other interesting conclusions on the effect of superheat, for which reference should be made to the report. The work of the committee is proceeding without interruption, and has been greatly assisted by contributions from the British Electrical and Allied Industries Research Association.

International Conference on Soil Science.

THE fourth International Conference on Soil Science was held in the building of the International Institute of Agriculture at Rome on May 12-19, when between 120 and 150 delegates from various countries were present. The Ministry of Agriculture appointed the following delegates from Great Britain : Dr. N. M. Comber, Dr. B. A. Keen, Mr. H. J. Page, and Mr. G. W. Robinson.

The general organisation of the conference was in the hands of Prof. Hissink, of Groningen, Holland, and the actual arrangements for the meeting were carried out by local committees in Rome.

In all, some 250 papers were presented to the conference, distributed over the following sections :

1. (*a*) Physical Properties, and Mechanical Analysis of Soil.
   (*b*) Application of Soil Science to Field Conditions.
2. Chemical Properties of Soil.
3. Biochemical and Bacteriological Studies.
4. Soil Classification.
5. Soil Surveys and Maps.
6. Physiological Studies in Relation to Soil.

These sections met both independently for the consideration of their own papers, and jointly for discussions of common interest.

In addition, the following lectures were given during the conference :

La nitrification et ses conséquences agricoles, Prof. G. André (Paris) ; Recent Advances in Soil Physics, Dr. B. A. Keen (Rothamsted) ; Dispersoidchemie und Bodenkunde, Prof. G. Wiegner (Zurich) ; Die modernen Ziele zur Erforschung der Bakterientätigkeit im Boden, Prof. J. Stoklasa (Prague) ; The Fertiliser Industry of the United States in Relation to Soil Science, Prof. J. G. Lipman (New Jersey) ; Analisi del terreno e suo valore, Prof. A. Menozzi (Milan).

Some considerable time before the conference, arrangements had been made for certain outstanding questions to be studied co-operatively by workers in different countries. The reports of these investigations formed an important section of the conference. Among them may be mentioned an investigation of the various methods employed for dispersing soil samples prior to a mechanical analysis. Samples of two given soils were distributed to each worker so that the results of the various methods were strictly comparable. The mechanical analyses showed considerable variations, not only among the different methods, but also for the same method in the hands of different workers. The studies are to be continued and extended in view of the vital importance of complete dispersion of the soil suspension for the newer methods of mechanical analysis, such as those of Odén and Robinson, which depend on one single sedimentation.

Further joint discussions took place on the question of base exchange in soils and on the production and cause of soil acidity. It cannot be said that any general agreement emerged from these discussions, nor in the present state of our knowledge would this be expected. The contributions of Ramann and Wiegner on base exchange were noteworthy. The former supported the view that base exchange alone is produced by neutral salts ; hydroxides and salts with alkaline reaction give base exchange and adsorption ; acids and acid salts decompose the silicates, and an exchange between the cations of the silicates and the hydrogen of the acids causes the formation of acid soils. Wiegner developed the view that base exchange in clay or soil is a special case of the so-called "polar" exchange-adsorption, and is intimately linked up with the degree of dispersion of the clay. On this view a clay particle may consist of an aggregate of smaller particles. The total surface of the compound particle is available for base exchange phenomena, while the electrical properties of the aggregate are a function of its outer surface only.

All the six sections combined for the discussion on soil acidity. The chief value of this discussion, which extended over too wide a range for an adequate summary to be given here, was the opportunity afforded for those studying the subject from the physico-chemical aspect to appreciate the problem from the physiological point of view, and vice versa. A number of the speakers dealt with the efforts made to develop a field technique on which practical recommendations as to liming could be based. Prof. Hissink described his quantitative adaptation of the well-known Comber test for sour soils that was now in extensive use in Holland as a means of measuring lime requirement. Dr. Comber directed attention to the danger in assuming that any qualitative test that showed a reasonable degree of quantitative relationship for any given soil type was suitable for general application.

Special mention must be made of the work of Section 5. In the face of considerable difficulties, financial and otherwise, a very complete account of the present position of soil survey work was collected from experts in many different countries. With the assistance of the Geological Institute of Rumania, Bucharest, Profs. Murgoci and Opresco were able to have these memoirs printed for distribution to the conference. The volume forms a most valuable record of the present state of the subject, and will be of great value for comparative studies.

In connexion with the conference, a small exhibition of apparatus, maps, etc., was held. Several members took this opportunity of demonstrating the apparatus they had already described at the conference. The younger German workers are showing considerable activity in devising field instruments. The problem of measuring the moisture content of soils *in situ* by means of the electrical resistance has been attempted before, but the apparatus was not satisfactory. The new method of Dr. Götz, of Berlin, is based on the same principle, but is a distinct improvement and appears to be of great promise. Dr. Trenel, of Berlin, demonstrated an apparatus for measuring the P_H of soils *in situ*.

Perhaps the chief value of a conference such as this lies not so much in the meetings and reports as in the numerous opportunities afforded for informal discussions with workers from other countries. The conference was well served in this respect, as the local committee arranged several receptions and excursions during the meeting. The Italian Government took an active interest in the proceedings ; the King was present at the opening of the conference, and the Minister of National Economy attended the closing meeting.

The final act of the conference was to establish an International Society of Soil Science, having as objects the promotion of soil science by means of conferences, the formation of special committees for co-operative work, the publication of a review, and the institution of a central office in the International Institute of Agriculture at Rome, where all reports and documents can be filed, and from which members can obtain information needed in their work.

The first president is Prof. J. G. Lipman, of the New Jersey Experimental Station, and on his invitation, the conference appointed America as the place for the fifth meeting. The following were elected

honorary members: Prof. Cayeux (France), Prof. Glinka (Russia), Prof. Murgoci (Rumania), Prof. Ramann (Germany), Sir John Russell (England), and Prof. Winogradsky (France). The acting-chairman and general secretary is Prof. Hissink, Groningen, Holland. The International Mitteilungen für Bodenkunde has been taken over as the official journal of the society, and will be in future published by the International Institute of Agriculture at Rome.

The society has undoubtedly an important future, and it is hoped that it will have many British members. Further information can be obtained from either Prof. Hissink or Dr. B. A. Keen, Rothamsted Experimental Station, Harpenden. B. A. KEEN.

International Mathematical Congress.

DURING next August, Toronto is to be the scene of two great scientific gatherings. The British Association will hold its ninety-second annual meeting on August 6-13, and an International Mathematical Congress will be held on August 11-16. International gatherings of mathematicians have previously been held in Zurich (1897), Paris (1900), Heidelberg (1904), Rome (1908), Cambridge (1912), and in Strasbourg (1920). The North American continent is for the first time the meeting place of such an assembly. The natural boundary of distance, with the incident expense of transportation, is being in a large measure overcome by the generosity of the Governments of the Dominion of Canada and the Province of Ontario, each of which is making a contribution of 25,000 dollars to defray the expenses of the Congress. The greater part of these funds will be used to assist the passage of eminent European men of science, mathematicians, and representatives of those sciences and professions which apply mathematics. It is estimated that the attendance from Europe will exceed one hundred and fifty. The British representation on the applied side promises to be large. At least twenty will come from France, nearly as many from the Scandinavian countries, and more than a dozen from Italy. Not less than fifteen European countries will be represented. The attendance from Canada and the United States is expected to run into the hundreds.

Difficulties in arranging suitable dates for the Congress delayed the sending out of notifications. The Organising Committee has tried to notify all those likely to be interested resident in countries adherent to the International Mathematical Union, or eligible for adherence thereto. In all, some six thousand notifications have been sent out, and a large number of universities and learned societies have been invited to be represented by delegates. Among those bodies which will be represented are the National Committees of the International Mathematical Union. These Committees are, as a rule, appointed by the National Academies of the respective countries, and through them the Academies might be regarded as obtaining representation. Many of the Academies, however, will, in addition, be directly represented. This, for example, will be the case with the Reale Accademia dei Lincei and the Académie des Sciences de l'Institut de France. Many specialised scientific societies too have named delegates. Among such are the Société Mathématique de France, the Circolo Matematico di Palermo, the American Mathematical Society, the Physical Society of London, the Société Française de Physique, the Royal Astronomical Society, the Royal Meteorological Society, and sister societies in a number of different countries. Statistical and actuarial societies will also be represented. The Institution of Naval Architects, the Institution of Electrical Engineers, the Institution of Mechanical Engineers, and other engineering organisations have appointed representatives. The same is true of the British Association and the corresponding organisations in France and the United States. The National Physical Laboratory and the Bureau of Standards have also named delegates, while many universities will be represented, including, among others, Cambridge, Paris, and Rome.

The Congress is being held under the auspices of the University of Toronto and the Royal Canadian Institute, and will be conducted in accordance with the regulations of the International Research Council. Prof. J. C. Fields, president of the Royal Canadian Institute, is chairman of the Organising Committee, and the other members of the Committee are Sir Robert Falconer, president of the University of Toronto, Prof. A. T. DeLury, Prof. J. C. McLennan, Prof. C. A. Chant, Mr. T. H. Hogg, Dr. J. S. Plaskett, Prof. M. A. Mackenzie, Prof. E. F. Burton, Mr. J. Patterson, Mr. W. P. Dobson, Wing-Commander E. W. Stedman, and Prof. J. L. Synge (secretary). Dr. F. A. Mouré, bursar of the University of Toronto, is acting as treasurer. An Editorial Committee has been organised, with Prof. Fields as chairman. There are also associate committees to deal with hospitality, excursions, printing, publicity, meeting rooms, signs and messengers, finance and transportation.

An excursion has been arranged for a selected party to the Western Provinces on special trains, leaving Toronto on the night of Sunday, August 17, and returning in about three weeks' time. There will also be an excursion through Northern Ontario, and excursions to Niagara Falls on August 9 and August 16, the route being by steamer across Lake Ontario, the journey each way taking about two hours.

The Congress will meet in the following sections:

Section I. Algebra, theory of numbers, analysis.
Section II. Geometry.
Section III. (*a*) Mechanics, mathematical physics.
(*b*) Astronomy, geophysics.
Section IV. (*a*) Electrical, mechanical, civil and mining engineering.
(*b*) Aeronautics, naval architecture, ballistics, radiotelegraphy.
Section V. Statistics, actuarial science, economics.
Section VI. History, philosophy, didactics.

It will be observed that this scheme of sections differs from those adopted at former congresses in the additional attention devoted to the applications of mathematics. It has been devised in order to secure in the sphere of applied mathematics full opportunity for consideration not only of those questions the interest of which is purely scientific, but also practical problems of engineering the solutions of which contribute directly to the cause of material progress.

The Organising Committee would be obliged if those who expect to attend the Congress would notify the secretary to that effect, stating their order of preference in accommodation from a choice of hotel, boarding-house, or university residence. Abstracts of papers intended for presentation should be in the hands of the secretary well in advance of the meeting.

Further information may be obtained from Prof. J. L. Synge, secretary of the Organising Committee, International Mathematical Congress, Royal Canadian Institute, 198 College Street, Toronto, Canada.

The Physical and Physico-chemical Problems relating to Textile Fibres.

IN the joint discussion held by the Faraday Society and the Textile Institute at the British Empire Exhibition, Wembley, on June 11, under the presidency of Sir Robert Robertson and Mr. Lester, a number of important developments of research on textile fibres was disclosed. The papers covered a wide field and dealt with the physical properties of cotton, wool, flax, and silk fibres. It is intended in this article to describe some of the points raised during the discussion rather than to refer in detail to the subject-matter of the papers, which is to be published later.

The introductory address was given by Dr. W. L. Balls, who proposed to divide physical research in textiles into two sections: (1) that relating to the physical unit in each raw material; and (2) that relating to the larger field concerned with the building up of the yarn and fabric. The appropriateness of this division is at once apparent; it separates, at least vaguely, the bio-physical problems from the mechanical ones, implying by the latter those problems concerned in the transformation of a mass of raw material into a useful yarn or fabric. In his conclusion Dr. Balls said: "The defects of yarn and fabrics which admittedly exist, together with other defects whose existence is not even recognised, were formerly due to faults in the machinery employed. Many of these have been eliminated in the course of time; and the physicist is now concerned rather with studying the causation of defects which are inherent in the properties of the raw material."

This warrants a note of criticism. The present writer pointed out that though the importance of physical tests on raw materials cannot perhaps be overstated, at any rate from the grower's point of view, yet at the same time it should be clearly understood that there are, on the industrial side, limitations to the profitableness of such work. I refer particularly to trade samples of raw material. It would no doubt be an easy though laborious matter to obtain valuable information concerning certain characteristics of the cotton fibres and their correlations, for example, provided one confines the effort to one or more special varieties. But it must be borne in mind that the practical spinner has no direct interest in special varieties; he buys and mixes his raw material according to market prices. Such raw material makes physical research on the "textile unit" a most uncertain and despondent field when the results are interpreted according to the expectations of the spinner or manufacturer. To take an example, it is now known that the lustre of a doubled yarn depends on a certain relationship between the constants for spinning the singles and for doubling them. If this condition is not satisfied, it is easy to make a highly lustrous raw cotton into a less lustrous yarn than might have been produced by using a less lustrous cotton and working it properly. This is quite apart from the measurable characteristics of raw cottons, such as staple length, fineness, or convolutions, etc., and shows that the relative *position* of the fibres, determined by the spinning processes, is at least as important as the properties of isolated fibres. Again, the percentage irregularities of yarns spun from high- and low-grade cottons are about the same, so that this important property does not depend appreciably on the raw material. Such examples might be multiplied a hundred-fold. While not denying that many of the defects existent in yarns and fabrics are rightly concerned with variability in the raw material, it is necessary to emphasise the fact that many defects are traceable to the machines, scarcely one of which, in the writer's opinion, cannot be improved by physical research. Dr. Balls' remark that "the utility of the scientist in industry is largely conditioned by the degree of stability of the industry" is only too true; it enforces the necessity for work on the complex mixtures of raw material almost universally used in practice, and leads us to the conclusion that work of this character is the more immediate. Furthermore, it is the duty of the Textile Industrial Research Associations to supply such practical information while still keeping a preserve for work on "textile units," which, it is hoped, will eventually be of vital importance to the producer of the raw material.

Dr. S. A. Shorter dealt with the nature of the recovery from strain of the wool fibre, in particular, attributing the creep to the combined effects of elastic and impeded elastic portions of the fibre structure rather than to its plasticity, to which property other authors have ascribed the effects. He stated that the elasticity of wool approaches the ideal, the hysteresis being almost entirely a true effect, and suggested that the fibre acts as a two-phase system, including (*a*) a perfectly elastic framework, (*b*) a viscous fluid; the two affording a complete explanation of the phenomena observed in the finishing of woollen and worsted fabrics. Mechanical models were described to illustrate the type of structure advocated, and the system of impeded elastic elements was used to explain how the shedding fault arises in a loom which has been standing over (say) the week-end.

Some experiments on loaded gelatin sticks were described by Mr. Pool, who concluded that the elastic effects observed in such purely colloidal systems were analogous to those simulated by Shorter's model. It was pointed out by Dr. Mardles that similar effects were common in many materials, *e.g.* steels, time and stress introducing new phases initiated by molecular changes. Mr. Peirce thought the effects were due to impeded but reversible orientations within the mass and these effects were ultimately inherent in the molecules themselves. In his paper on the fibre balance, Dr. Barratt described load-extension diagrams showing the relative degree of non-recovery from strain in wool, cotton, silk (viscose) and flax, the order, as indicated, being decreasing. Dr. Shorter was of the opinion that in the case of the wool fibre, practically all the residual strain would disappear by wetting, while he agreed that with cotton fibres a small amount of non-recovery persists.

Two important communications were made by Dr. T. Barratt on the lustre of cotton fibres and the transparency of fabrics. The lustre comparisons were made by a special arrangement of a Joly photometer, the fibre pads being so mounted that varying angles of incidence and diffusion could be obtained, and also so that they could be rotated in their own plane. Unmercerised and mercerised cotton and glass fibres were tested and the conclusions drawn that (1) the light reflected from a mercerised fibre in certain positions is concentrated within a small angle; (2) the light from an unmercerised (twisted) fibre is scattered over a wide angle; and (3) the lustre is enhanced when a number of mercerised fibres are laid parallel to each other (the case of a sateen with "floating" threads). The increased lustre shown by a mercerised fibre is due to light regularly reflected in a plane containing the length of the fibre. In keeping with this result, the work of the writer and Mr. Adderley was mentioned, which showed that in doubled yarns the optimum lustre was obtained when the fibres in the doubled yarn are parallel to its axis, so that, looking

along the yarn, the light is mainly reflected along the length of the fibres.

Using the Joly photometer, measurements of (1) the total transparency of fabrics (defined as percentage of incident light transmitted), (2) thread transparency (the percentage of light falling on the threads alone, which is transmitted), were made. The determination (2) was made possible by dyeing the threads black and so obtaining a measure of the light transmitted by the spaces alone. From the combined readings it is then possible to calculate the total light incident on threads *alone* and that transmitted by threads *alone*, which is a measure of thread transparency.

Mr. C. R. Nodder showed slides of the structural characteristics of compressed flax fibres, up to fifty daily growth rings being visible, and also the spiral fibrillæ in each layer. Herzog and Jancke have obtained X-ray point diagrams with flax and ramie fibres which they attribute to a rhombic (or monoclinic) symmetry of constituent crystallites. With powdered fibres they obtained diffraction rings confirming this result. Flax and ramie fibres subjected to similar compression presented optical effects which indicate the true crystalline nature of their structure.

A large number of physical data relating to the silk fibre (the ultimate filament of fibroin, two of which, gummed together by sericin, form the cocoon thread) were detailed by Dr. W. S. Denham. The most interesting of these concern the crystalline structure found by Herzog and Jancke. Some measurements on the lustre of silk fibres with the plane of incidence perpendicular and parallel to the fibre length were discussed in terms of the arbitrary expressions for lustre recommended by Zart, Schultz, and Adderley, and Dr. Denham reasonably advocated some universal standard. The lustre is greater with the plane of incidence containing the fibre length (cf. Barratt, *supra*). The thermal conductivities of textiles have been measured by Miss Rood; the values, for the same density, increasing in the order, silk, wool, artificial silk, linen, and cotton.

An interesting account of experiments on the tautness of aero-fabrics was given by Dr. Ramsbottom, who pointed out that though dope may be regarded as the primary factor in fixing tautness, still the nature of the fabric is of importance in maintaining this property at high humidities and after long exposure. Fabrics woven from fine yarns preserve tautness better than those containing coarser yarns, and linen, cotton, and silk all give satisfactory tautness at low humidities. With cotton and linen, at high humidities the tautness falls but recovers with absorption of water by the fabric, whereas with silk the tautness falls off continuously, so that silk fabrics are inferior to others. Mercerised cotton is preferable to unmercerised cotton or linen. Measurements on strength and deterioration on weathering were given. Dr. de Waele asked if it were possible to obtain a mesh of (say) silk and cotton which would have constant tautness, in reply to which Mr. Crompton said it was quite feasible to double artificial silk and cotton to test this point.

The action of light on textiles was discussed by Dr. Barr, who laid stress on the difficulties of measuring the photochemical action due to sunlight, which is the real aim of such research. With sunlight the spectrographic method has given negative results, while only incomplete data have been obtained by using glass screens. The method of first dyeing the fibres and exposing them to white light has given some practical results, but these are difficult to interpret, being complicated by the ill-defined nature of the light stimulating the reaction and the possibility of unknown interaction between fibre, dye, and the reaction products.

With the mercury arc in quartz, rapid deterioration of textile fibres may be developed, but such effects cannot be safely translated into terms of sunlight. Cellulose is very sensitive to wave-lengths less than 3000 Å.U., which exist in the mercury arc but not in sunlight. Aston's work on cotton and linen threads (for aero-fabrics) indicates that with light from the mercury arc, the most destructive rays have wave-lengths less than 3990 Å.U., a conclusion which has been verified by Ramsbottom by using coloured glass screens. Two hundred hours' exposure to sunlight produced no effect. Assuming that ionised oxygen is responsible for the deterioration, Lindemann has deduced from the quantum theory that the most destructive radiation has a wave-length of 3230 Å.U.

Very little is known about the tendering action of light on other textile fibres. Silk appears to be considerably more affected than linen, while wool is almost immune.

Mr. F. D. Farrow referred to some recent advances in the experimental study of warp sizing, and dealt with the work of Owen and New on the oscillating resisting properties of yarns, and that of Farrow and Lowe on the viscosity of starch pastes. The work on viscosity involves a modified Poiseuille's equation, a "coefficient of flow" being measured which is proportional to a power of the pressure, the index varying between 1 and 2.

A review of the recent work on the moisture relations of textile materials was contributed by Mr. A. R. Urquhart and Dr. A. M. Williams. The hysteresis effects observed in the authors' work have been interpreted in terms of Zsigmondy's theory of the existence of capillary spaces within a gel, which, in the case of cotton, have a diameter of the order 13×10^{-8} cm. A study of the rates of absorption and desorption indicates that these processes are discontinuous.

A paper on the effect of water in the wet-spinning of flax was given by Dr. W. H. Gibson, who held the view that the process was conditioned by a gradual variation in the fibre constitution from pectin through intermediate products to cellulose. There is apparently a considerable breakage of the fibres (about 12 in. long) with a drafting reach of $3\frac{1}{4}$ in., as might be expected, and frequency curves showing the displacement of the breaking load modes of the yarn and rove confirm this.

In addition to the papers submitted for discussion, a number of interesting slides of linen fabrics from Tutankhamen's tomb were exhibited by Dr. A. Scott. These depicted (*a*) a linen veil, unbleached, 150-160 threads per inch × 80 threads per inch, in reflected and transmitted light; (*b*) a pall of much coarser linen fabric; and (*c*) a very friable linen fabric having two threads one way and one the other.

Sir Robert Robertson pointed out the great importance of obtaining further knowledge of the action of light on fabrics, and Mr. Lester remarked that we knew next to nothing about the life of a fabric, recalling the process of laundering and the effect of acid. In a few months a fabric might lose 60 per cent. of its strength.

A. E. OXLEY.

University and Educational Intelligence.

BIRMINGHAM.—The degree of Ph.D. has been awarded to the following candidates, the subjects of the theses being indicated in each case: Mr. N. F. Budgen (Researches with cadmium); Mr. Denis Bunting (An investigation of the brittle ranges of brass); Mr. Kamil Iskander (The development of precision measuring instruments for the determination of the heating value of gases); Mr. T. D. Jones

(The strata temperatures of the South Wales coal field, and causes of variation in the same; Hygrometric observations in South Wales collieries).

DUBLIN.—Among the honorary degrees which have been conferred at Trinity College are the following: *D.Sc.*: Prof. R. A. Millikan, of the California Institute of Technology, Pasadena, and Prof. E. B. Poulton, Hope professor of zoology in the University of Oxford; *D.Litt.*: Prof. Ernest A. Gardner, Yates professor of archæology, University College, London.

LEEDS.—Mr. A. Seymour-Jones has presented to the Leather Industries Department his library, consisting of about 200 books on leather and kindred subjects, and a set of framed photomicrographs for display in the Department.

It has been decided to institute a lectureship in medical radiology and electro-therapeutics, and to appoint thereto Dr. Scargill and Dr. Cooper as joint lecturers. Mr. William Davies has been appointed demonstrator in engineering.

LONDON.—Prof. E. A. Gardner, Yates professor of archæology in the University, tenable at University College, has been elected Vice-Chancellor for 1924–25 in succession to Mr. H. J. Waring.

Dr. B. B. Baker has been appointed as from October 1 to the University chair of mathematics, tenable at the Royal Holloway College. Since 1920 Dr. Baker has been lecturer in mathematics at the University of Edinburgh; in 1921 he was elected a fellow of the Royal Society of Edinburgh and hon. secretary of the Edinburgh Mathematical Society. His published work includes various articles in mathematical and scientific journals.

Dr. C. L. Burt has been appointed as from August 1 to the University (part-time) chair of education, tenable at the London Day Training College. From 1908 to 1912 Dr. Burt was lecturer in experimental psychology in the University of Liverpool, and from 1912 to 1913 assistant lecturer in the Psychological Laboratory, Cambridge. Since 1913 he has been psychologist in the Education Department of the London County Council. He has published a number of works on intelligence tests and allied subjects.

The title of professor of surgery in the University has been conferred on Dr. C. C. Choyce in respect of his appointment as Director of the Surgical Unit at University College Hospital Medical School.

The title of reader in geology in the University has been conferred on Mr. H. Gladstone Smith in respect of the post held by him at East London College. Mr. Smith has been lecturer in geology at East London College since 1918.

The title of professor of physics in the University has been conferred on Prof. O. W. Richardson in respect of his part-time appointment as Director of Research in the Department of Physics at King's College. Prof. Richardson will cease to hold the Wheatstone chair of physics, which he has occupied since 1914, on taking up the Yarrow Research Professorship of the Royal Society on August 1.

Sir Hermann Gollancz has given his library to University College to commemorate his twenty-one years' tenure of the Goldsmid professorship of Hebrew. Mrs. Preedy has presented to the University library a valuable collection of books on Greek and Roman archæology and art, formerly belonging to her son, the late J. B. Knowlton Preedy, who served for some years prior to the War as a secretary in the University Extension Department.

The following doctorates have been conferred:—D.Sc. (*Chemistry*): Miss M. L. V. Gayler (Bedford College), for thesis entitled "The Constitution and Age-hardening of the Quaternary Alloys of Aluminium, Copper, Magnesium, and Magnesium Silicide"; D.Sc. (*Physiology*): Mr. J. A. Hewitt (King's College), for a thesis entitled "Metabolism of Carbohydrates (Part III.)"; D.Sc. (*Physiology*): Mr. F. M. R. Walshe (University College and University College Hospital Medical School), for a thesis entitled "(i.) The Physiological Significance of the Reflex Phenomena in Spastic Paralysis of the Lower Limbs, (ii.) On certain Tonic or Postural Reflexes in Man, with special reference to the so-called 'Associated Movements,' (iii.) On Variations in the form of Reflex Movements, notably the Babinski plantar response, under different degrees of Spasticity and under the influence of Magnus and de Kleijn's Tonic Neck Reflex"; D.Sc. (*Geology*): Mr. Ernest Neaverson, for a thesis entitled "Ammonites from the Upper Kimmeridge Clay."

A degree of M.Sc. in the principles, history, and method of science has been instituted for both internal and external students.

MANCHESTER.—Applications are invited for the headship of the department of pure and applied physics in the College of Technology. The position carries with it the title and status of lecturer in the University. The latest date for the receipt of applications, which should be sent to the Registrar of the College, is July 16.

OXFORD.—Among the recipients of honorary degrees at the Encænia held on June 25 were Sir Humphry Rolleston, Bart., president of the Royal College of Physicians, and Prof. S. Alexander, professor of philosophy in the University of Manchester, who received the degrees of D.Sc. and D.Litt. respectively.

PROF. SYDNEY CHAPMAN, at present professor of mathematics and natural philosophy in the University of Manchester, has accepted the invitation of the Governing Body of the Imperial College of Science and Technology to undertake the chief professorship of mathematics at the Imperial College beginning in September next, in succession to Prof. A. N. Whitehead, who has been appointed to the chair of philosophy at Harvard University, U.S.A.

AT the universities' conference held at Simla in May it was decided that an Indian inter-university board should be constituted with one representative of each university, to facilitate the co-ordination of university work, to assist in obtaining recognition in other countries of Indian degrees, diplomas, and examinations, to act as an appointments bureau for Indian universities, to facilitate the exchange of professors, and generally to fulfil such duties as may be assigned to it from time to time by the Indian universities. The cost of maintenance of the board is to be met by equal contributions from the universities, but the Government of India and the provincial governments are to be asked to make a grant towards its expense. It has for some years been recognised that some such co-ordinating body was needed, and in April 1920 a committee was formed for drafting an outline of its functions and constitution. The project was further advanced at the Congress of Universities of the Empire in 1921, but the universities were not unanimously in favour of the proposals then formulated. The board now to be set up will be the Indian counterpart of the Conference of Canadian Universities, the Standing Advisory Committee of the Australian Universities, the Vice-Chancellors' Committee of South Africa, and the Standing Committee of Vice-Chancellors and Principals of the Universities of Great Britain and Ireland.

Early Science at the Royal Society.

June 29, 1681. In discussion the president [Wren] observed, that it was necessary, that all wholesome food should have oils: that most roots wanting oil are not of themselves a good nourishment: and that in Ireland, where the people feed much on potatoes, they help themselves by drinking milk soured, to make the potatoes digest the better.

June 30, 1686. Ordered, that the treasurer, to encourage the measuring of a degree of the earth, do give to Mr. Halley fifty pounds or fifty copies of the "History of Fishes," when he shall have measured a degree to the satisfaction of Sir Christopher Wren, the president, and Sir John Hoskyns.

July 1, 1663. Mons. Moncony's description of the way used in Egypt of hatching in ovens, was read, and ordered to be registered. He was of opinion, that the temperament of the air in Egypt contributed greatly to the method of hatching chickens, since the grand duke having sent for some of the christians of Cairo, who are the only persons, that carry on that business, they had built an oven at Florence, but failed of hatching chickens.

1680. Sir Christopher Wren affirmed, that extreme freezing will sweeten salt water: that the curd which is then upon the surface of the water, will be found sweet: that this is found in Hudson's Bay: and that a little hole left in a window in winter, and a little fire in the chimney, will freeze anything to a great degree.

July 2, 1662. It was ordered that the committee appointed to view the Towgood's engine, meet the Saturday following afternoon in the Temple church. —A new astronomical hypothesis of a stranger was referred to the consideration of Dr. Wren [and others].

1668. The experiments appointed for this meeting not being prepared by reason of the operator's indisposition, it was ordered that on the like occasion another person should be hired and made use of *pro tempore* to do the manual part, that the Society might not be destitute of experiments.

July 3, 1661. Mr. Croune to procure, against the next meeting, some fresh vipers; and the operator to provide fresh hazel-sticks.—Mr. Evelyn presented his relation of graving and etching; and, after public thanks returned to him, was requested to transcribe it.

1672. Dr. Grew was put in mind to see, what might be discovered of the peristaltic motion in plants, asserted by Signor Malpighi.—Mr. Hooke was called upon for making a report concerning Signor Cassini's paper concerning the satellites of Jupiter, and desired to give in writing what he had said upon it that it might be without mistake imparted to Signor Cassini, who had desired that favour.

1679. It was ordered that Mons. Papin be employed for the writing of all such letters, as shall be ordered, to the correspondents of the Society: and that for so doing the said Mons. Papin shall receive the sum of eighteen pence per letter, unless the letter shall exceed two sides of a quarter of a sheet of paper; for every of which he shall receive two shillings.

July 4, 1678. A letter was read to the meeting written by Jacobus Pighius, dated at Padua, wherein he expressed the high respect which he had for the Society, and his great desire of being known to them. He mentioned his esteem for the English in general, and the favour done him by the English students at Padua, in choosing him their pro-syndic.

1683. It being thought proper, that some man should be appointed to keep the door of the meeting-room during the time that the Society was assembled, the porter, who removed the seats, was ordered to wait, and to have 12*d.* a time, when he waited.

Societies and Academies.

LONDON.

Royal Society, June 19.—J. C. **McLennan** and G. M. **Shrum**: On the luminescence of nitrogen, argon and other condensed gases at very low temperatures. Experiments are described on the luminescence of nitrogen and argon at the temperature of liquid hydrogen under electronic irradiation. The spectra of the light emitted by both elements contains wavelengths close to but not coincident with that corresponding to the auroral green line. Both solid nitrogen and solid argon phosphoresced brilliantly under electronic excitation. From these experiments there is no confirmation of Vegard's theory that the auroral green line originates in vaporous solidified nitrogen.—H. Grayson **Smith**: On the fine structure of the band spectra of sodium, potassium and sodium-potassium vapours. Four bands of the blue-green group of the band absorption spectrum of sodium and three bands of the red group of the band spectrum of potassium have been examined. Two values of the moment of inertia of the normal sodium molecule have been found from different bands, $2{\cdot}515$ and $2{\cdot}286 \times 10^{-39}$ gm.cm.^{2}. Assuming that the molecule is diatomic, the corresponding values for the distance between the nuclei are $1{\cdot}151$ and $1{\cdot}098 \times 10^{-8}$ cm. The moment of inertia of the potassium molecule is $18{\cdot}39 \times 10^{-39}$ gm.cm.^{2}, so that the distance between the nuclei of a diatomic molecule is $3{\cdot}069 \times 10^{-8}$ cm., which is in fair agreement with X-ray measurements. Two bands of a new group found by Barratt in the absorption spectrum of a mixture of sodium and potassium vapours give a moment of inertia of $6{\cdot}615 \times 10^{-39}$ gm.cm.^{2}. This agrees with the supposition that these bands are due to NaK molecules, the distance between the nuclei being $2{\cdot}137 \times 10^{-8}$ c.m.—Lord **Rayleigh**: (1) The non-luminous oxidation of phosphorus in an oxygen atmosphere. The views on phosphorescent combustion of phosphorus developed in former papers require that phosphorus vapour, when apparently inactive in an atmosphere of oxygen, should in reality be combining with it at isolated centres, though the action fails to spread. Either this action or the ordinary phosphorescent combustion can be caused to occur *at one given pressure and external temperature.* The rate of oxygen absorption is widely different in the two cases. With a given area of phosphorus surface, the rate of action is enormously increased by allowing a large oxygen space around it. The action occurs in the volume of the gas space, and therefore between oxygen and phosphorus vapour. (2) The light of the night sky: its intensity variations when analysed by colour filters. The comparison light is a uranium salt rendered self-luminous by radio-activity. Three alternative colour filters are provided; one of these approximately isolates the green aurora line. A red and a blue filter isolate the regions of the spectrum on either side of this line, excluding the line itself. The light of the sky as seen through these is equalised with the standard by means of neutral tinted glasses. Owing to faintness of the light, colour differences are not perceptible. Systematic observations of the auroral light for fifteen months, and of the other components for seven months, show variations which are far too large to be explained by changes in atmospheric transparency. The highest values of the auroral light were found during October 1923, which was the middle of a period of three months showing considerable sunspot activity. For the rest of the time there were few spots. The auroral light varies very little over the whole range of latitude from England to the Cape of Good

Hope. The polar aurora is contrasted with this non-polar aurora. The latter may be a phenomenon of phosphorescence, the luminosity being excited by the sun during daytime and carried round by the earth's rotation as in the phosphoroscope. The light of the night sky is much richer in red, measured relative to blue, than is daylight. In this respect it approximates to the light of a ½-watt incandescent lamp.—W. G. **Palmer** and F. H. **Constable**: The catalytic action of copper. Pt. IV. By measuring the velocity of dehydrogenation of alcohol passing over copper film catalysts when the temperature of the catalyst is rising and again when it is falling, a measure of the temperature coefficient of the change is obtained. Above a temperature of 280° C. the adsorbed alcohol film becomes unimolecular, and the aldehyde bombarding the bare copper surface polymerises and causes decay of the activity by covering the surface. No evidence of decay due to sintering was obtained during the experiments, which lasted up to five hours. The catalytic activity varied with the temperature of reduction of the copper oxide in a periodic manner; in general the greater the activity of the catalyst the less the temperature coefficient. Reduction at 420° C. seems to change both the grain structure and the nature of the surface. The "heat of activation" of an alcohol molecule is held to vary with the arrangement of the atoms in the surface on which it is adsorbed.—Rev. A. L. **Cortie**: The 27-day period (interval) in terrestrial magnetic disturbance. At a period approaching minimum solar activity (May 1921–July 1923), the persistence of notable magnetic disturbances in series at a 27-day interval, when the sun was entirely free from spots, and even sometimes of bright faculæ and flocculi, led to two long sequences of such disturbances, May 12, 1921–April 13, 1923, containing 26 synodic recurrences, and October 27, 1921–July 10, 1923, embracing 23 recurrences. In each sequence, from the magnetic data alone, a mean solar latitude has been computed, and a mean solar longitude, which fit accurately two regions of intermittent solar activity, one in the sun's northern hemisphere, and the other in the southern hemisphere. Moreover, these two regions, separated by about 180°, practically contained all the sunspots that had appeared in the period discussed. But there is no parity between the intensity of sunspot or floccular activity, and of magnetic disturbance. In the period discussed, magnetic disturbances occurred without, but not independently of, solar activity in a restricted area.—E. K. **Rideal** and C. G. L. **Wolf**: The destruction of rennin by agitation: a case of catalysis at an air-liquid interface. Rennin solutions undergo a chemical destruction when agitated, due to a chemical reaction occurring at the air liquid interface. The second reactant is a capillary active substance which is present in ordinary rennin solutions, but can be removed by dialysis. The dialysable reactive constituent is probably a fatty acid.—W. G. **Palmer**: The use of the coherer to investigate adsorption films. Loose contacts or "coherers" formed of tungsten-tungsten, carbon-tungsten, and platinum-platinum surfaces have been studied with particular regard to the action of the gas surrounding them. The voltage required across the contact to effect full metallic conduction is, for a given gas, a constant practically independent of the pressure of the gas and varying between wide limits for different gases. The cohering action may be due to the evaporation of an adsorbed film of gas under electrical stress. From the critical voltage the latent heat of evaporation of the film is calculated.—R. J. **Lang**: On the ultraviolet spark spectra of some of the elements. The wavelengths are given for the following elements: carbon, calcium, titanium, vanadium, chromium, manganese, cobalt, arsenic, molybdenum, cadmium, tin, antimony, tellurium, cerium, platinum, gold, thallium, lead, bismuth, uranium, in the ultraviolet region. They range from $\lambda = 2000$ A to $\lambda = 224$ A.—W. T. **Astbury** and Kathleen **Yardley**: Tabulated data for the examination of the 230 space-groups by homogeneous X-rays. Diagrams are given, one for each of the 230 space-groups, showing the distribution of symmetry elements and the relative positions and orientations of the molecules in the unit cell; and accompanying these diagrams are tables giving the fundamental Bravais lattice, the number of asymmetric molecules per cell, the abnormal spacings to be expected, and the possible molecular symmetry for each space-group.—J. W. **Campbell**: On the drift of spinning projectiles. The following assumptions are made: (1) The shell is stable. (2) Its initial rotation is all about the axis of symmetry. (3) The resistance of the air can be represented by two forces, one along the axis of symmetry of the shell, and the other at right angles to the axis and in the plane of the tangent to the trajectory and the axis, the latter force acting at some point (variable) in front of the centre of gravity of the shell. When the initial oscillations have been damped out by air resistance, (2) is practically realised. Experiments show that the principal parts of the air resistance are represented by the force system (3). The solution obtained contains: (1) A formula for lateral drift. (2) Formulæ for the vertical and lateral components of the yaw. (3) A formula for cross-range wind deflexion. The solution is valid provided the yaw and the inclination of the axis of the shell to the plane of fire do not become too great, and it exhibits the well-known properties of the phenomena of drift.—A. L. **Narayan** and D. **Gunnaiya**: Absorption of lithium vapour. Absorption of the lithium vapour in the visible region has been studied. The vapour possesses channelled absorption spectrum both on the short and the long wavelength side of the first member of the principal series.

PARIS.

Academy of Sciences, June 10.—M. Guillaume Bigourdan in the chair.—A. **Haller**: The action of tetrachlorophthalic and tetrabromophthalic acids on turpentines. A new method of preparation of the camphols and therefore of the lævo- and dextro-camphors. The interaction of the tetrahalogenophthalic acids and pinenes gives bornyl, isobornyl and fenchyl tetrahalogenophthates, which by saponification give mixtures of these alcohols and their acid esters. The alcohols thus formed give fenones or camphors according to the terpene employed.—Charles **Rabut**: The scientific rules to be followed in structures of armoured concrete.—M. de **Sparre**: Pelton turbines working under a variable head.—J. Kampé de **Fériet**: A particular class of hypergeometrical functions of one variable.—Georges J. **Rémoundos**: The pairs of meromorp or algebroid functions corresponding to the points of an algebraic curve.—Octave **Mayer**.—A geometrical interpretation of the second fundamental quadratic form of a surface; in relation with the theory of parallelism of Levi-Cività.—P. **Dumanois**: The use of light alloys for the pistons of internal combustion motors.—A. **Barbaud**: Tracing lines of height and its application to aerial navigation over the sea.—T. **Peczalski** and A. **Launert**: The electrical resistance and density of copper cemented by salts.—P. **Bovis**: The absorption spectrum of bromine. The maximum absorption corresponds sensibly to the same wavelength for liquid bromine as for its vapour; but, calculated to the same weight of bromine, the maximum values are

different, the optical density of the liquid being more than double that of the vapour.—M. **Duffieux**: The origin of the first and second positive group of the band spectrum of nitrogen.—H. **Chipart**: The electromagnetic theory of optical activity and the postulate of MacCullagh.—H. **Pélabon**: The direct formation of the oxychlorides, oxybromides, and oxyiodides of mercury. Mercuric chloride, bromide, and iodide can unite directly with yellow or red mercuric oxide, dry or in the presence of water. In the last case the equilibrium is affected by alkali dissolved from the glass containing-vessel.—Stefan **Triandafil**: The influence of temperature on the galvanic polarisation of nickel.—René **Dubrissay**: The capillary phenomena which appear at the surface of separation of water and benzene in the presence of the fatty acids and of alkalies.—Francis **Perrin**: The law of decrease of the fluorescent power as a function of the concentration.—E. **Darmois**: The compounds of malic acid and copper. Measurements of the P_H and rotations of solutions of copper hydroxide in malic acid indicated the presence of two malates only, the acid salt and Liebig's basic salt.—M. **Bourguel**: The transformation of the substituted acetylene hydrocarbons into true hydrocarbons by sodium amide. Hydrocarbons of the type $RC{\equiv}C.CH_3$ are readily transformed by heating with sodium amide at 110° C. into hydrocarbons of the type $(CH_3)R.C{\equiv}CH$. The homologues $RC{\equiv}C.C_2H_5$ undergo a similar change, but much more slowly.—A. J. A. **Guillaumin**: The action of hydroxylamine on ethyl tartrate.—Alphonse **Mailhe**: The decomposition of chlorophyll extracts. Distilled with magnesium or zinc chloride, these extracts give a gas rich in carbon dioxide, a mixture of liquid hydrocarbons containing a high proportion of olefines, and a solid, probably dinonylketone $(C_9H_{19})_2CO$.—P. **Lasareff**: The mass of metallic iron contained in the ferruginous deposits at Koursk (Central Russia).—Albert **Nodon**: Observations on the propagation of the explosive waves resulting from the experiments at La Courtine. Details of the methods employed to measure the velocities of the air waves and earth waves caused by the explosions at La Courtine, distance 243 kilometres.—P. **Gillot**: Remarks on the determinism of sex in *Mercurialis annua*. This plant is unsuitable for investigations on sexual determinism.—A. **Maige**: The different stages of amylogenic condensation.—D. **Chouchack**: Influence of the nutritive elements on the development of soil bacteria.—F. **Granel**: The pseudobranchia of the selacians.—MM. **Barthélemy** and **Bonnet**: The influence of the temperature on the utilisation of energy in the course of the development of the egg of *Rana fusca*.—MM. J. E. **Abelous, Moog,** and **Soula**: Splenectomy and the demineralisation of the organism.—P. **Le Noir** and A. Mathieu de **Fossey**. Study of the ionic urinary acidity in normal man. The influence of food.—MM. **Pézard, Sand,** and **Caridroit**: Hormono-sexual modifications in adult Gallinaceae and the theory of specific form.

Official Publications Received.

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau Central de Magnétisme terrestre. Publiées par les soins de Prof. Ch. Maurain. Tome 2. Pp. viii+150. (Paris: Les Presses universitaires de France.)

Department of Agriculture and Natural Resources: Weather Bureau. Annual Report of the Weather Bureau for the Year 1920. Part 4: Hourly Results of Observations made at the Magnetic Observatory of Antipolo near Manila, P.I., during the Calendar Year 1920. Pp. 47. (Manila: Bureau of Printing.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 486: Some new Thermoelectrical and Actinoelectrical Properties of Molybdenite. By W. W. Coblentz. Pp. 375-418. (Washington: Government Printing Office.) 10 cents.

Annual Conference of the Universities of Great Britain and Ireland, 1924. Report of Proceedings. Pp. 63. (London: Universities Bureau of the British Empire.) 1s.

Diary of Societies.

SATURDAY, JULY 5.

INSTITUTION OF MECHANICAL ENGINEERS (Joint Meeting with the Institution of Civil Engineers), at 11.30.—Draft Standard Test Code for Hydraulic Power Plants, drawn up by a Joint Committee of the Institutions of Civil and Mechanical Engineers.

ROENTGEN SOCIETY AND THE ELECTRO-THERAPEUTICS SECTION OF THE ROYAL SOCIETY OF MEDICINE (Joint Meeting at the Radcliffe Infirmary, Oxford), at 3.30.—Sir Thomas Horder: The Influence of Radiology upon the Criteria of Disease (Mackenzie Davidson Memorial Lecture).—Prof. S. Russ: Experimental Studies upon the Lethal Dose of X-rays and Radium for Animal Tumours.

MONDAY, JULY 7.

INSTITUTION OF SANITARY ENGINEERS (at Royal United Service Institution), at 10 A.M. and 2.—International Conference.

PHOTOGRAPHIC CONVENTION (at Royal Photographic Society of Great Britain), in afternoon.—Presidential Address—Annual General Meeting.

FARADAY SOCIETY (at Chemical Society), at 7.45.—Annual General Meeting.—At 8.—G. R. D. Hogg: Note on the Conduction of Heat down the Necks of Metal Vacuum Vessels containing Liquid Oxygen.—C. L. Haddon: The Mechanism of Setting of Calcium Sulphate Cements.—J. J. Doolan and Prof. J. R. Partington: The Vapour Pressure of Tellurium.—E. E. Turner and W. H. Patterson: Cryoscopy in Sodium Sulphate Decahydrate.—D. B. McLeod: The Viscosity of Binary Mixtures.—J. B. Firth and F. S. Watson: The Catalytic Decomposition of Hydrogen Peroxide Solution by Animal Charcoal—The Production of Highly Active Charcoals.—Prof. A. J. Allmand and A. N. Campbell: The Electrodeposition of Manganese.—J. Grant: Concentration-Cells in Methyl Alcohol. Part II. Solutions containing Tetraethyl Ammonium Iodide.—F. H. Jeffery: The Electrolysis of Solutions of Potassium Oxalite with a Tin Anode and an Electrometric Determination of the Constitution of the Complex Anions formed.—F. J. Fraser: An Improved Form of Crook's Elutriator.

THE ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. H. Wildon Carr: The Scientific Approach to Philosophy.

TUESDAY, JULY 8.

INSTITUTION OF SANITARY ENGINEERS (at Royal United Service Institution), at 10 A.M. and 2.—International Conference.

INSTITUTION OF CIVIL ENGINEERS, at 8.30.—Prof. Elihu Thomson: Electrical Progress and its Unsolved Problems (James Forrest Lecture).

WEDNESDAY, JULY 9.

INSTITUTION OF SANITARY ENGINEERS (at Royal United Service Institution), at 10 A.M. and 2.—International Conference.

DECIMAL ASSOCIATION (Decimal-Metric Conference) (at Institution of Electrical Engineers), at 11, 2.30, and 4.30.—Discussion on Decimal Coinage—Ancient and Modern Weighing Appliances and other Appliances (Lecture)—Discussion on Metric System.

ROYAL SOCIETY OF MEDICINE (Sub-section of Proctology (Section of Surgery): Annual Clinical Meeting in conjunction with the American Proctologic Society), at 11.—Dr. Jackson: Quo vadis?—Dr. Beach: The Evolution of Proctology.—At 5.30.—Graeme Anderson and others: Discussion on The Injection Treatment of Hæmorrhoids.

RADIO SOCIETY OF GREAT BRITAIN (Informal Meeting) (at Institution of Electrical Engineers), at 6.—P. R. Coursey: The Manufacture of Condensors.

THURSDAY, JULY 10.

INSTITUTION OF SANITARY ENGINEERS (at Royal United Service Institution), at 10 A.M. and 2.—International Conference.

INSTITUTION OF ELECTRICAL ENGINEERS (Kelvin Centenary), at 12.30.—Dr. A. Russell: Address.

INSTITUTION OF CIVIL ENGINEERS (Kelvin Centenary), at 4.30.—Sir J. J. Thomson: Kelvin Centenary Oration.—Presentation of the Kelvin Medal, 1923, to Prof. Elihu Thomson.

ROYAL SOCIETY OF MEDICINE (Sub-section of Proctology (Section of Surgery): Annual Clinical Meeting in conjunction with the American Proctologic Society), at 4.30.—Dr. Montague and others: Discussion on The Treatment of Pruritus Ani.—Dr. Hirschman and others: Discussion on The Treatment of Rectal Prolapse.

FRIDAY, JULY 11.

ROYAL SOCIETY OF MEDICINE (Sub-section of Proctology (Section of Surgery): Annual Clinical Meeting in conjunction with the American Proctologic Society), at 4.30.—W. E. Miles and Mr. Lockhart-Mummery: Discussion on The Treatment of Cancer of the Rectum.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Supplement to NATURE

No. 2853 JULY 5, 1924

Insulin.[1]

By Prof. Hugh MacLean, Professor of Medicine, University of London.

NO recent discovery in medical science has created so much interest, both in lay and in professional circles, as the advent of insulin. The great importance of this discovery lies in the fact that through its agency a fresh outlook and a new hope have been opened up to the unfortunate sufferer from diabetes—an outlook in which despair and the prospect of almost certain death have given place to health and hope. From the humanitarian point of view, this itself is no mean achievement, but insulin has many interesting features besides its success in therapeutics, and the problem of its method of action presents an intellectual puzzle, which, from its complexity and obscurity, bids fair to engage our ablest scientific minds for many years to come.

Before discussing the results obtained from the use of insulin in diabetes, it is essential that certain points bearing on the metabolism of our foodstuffs should be clearly understood, for diabetes is nothing more than an interference with the normal mechanism which burns up our food in the body. Unlike the healthy individual, the diabetic subject cannot utilise his food, and, in consequence, becomes thin and ill. He presents the curious anomaly that the more food he eats the thinner and weaker he becomes, for, as the result of the perverse process of metabolism from which he suffers, much of the food that he is unable to use is changed into poisonous bodies which circulate in the blood, and cause destruction of body tissue, soon to be followed by death.

Though one of the most important symptoms of diabetes is glycosuria, or the presence of sugar in the urine, it is important to appreciate the fact that diabetes is a disease not of sugar or carbohydrate metabolism alone, but that the metabolism of all our foodstuffs is involved.

Metabolism of Foodstuffs in the Body.

Our knowledge of the various changes which the different foodstuffs undergo in the body is unfortunately very meagre, but we know sufficient to enable us to understand the main points in diabetes. Our food consists largely of starchy material or carbohydrate, with a certain amount of fat, and a fair proportion of such products as meat, fish, eggs, and other related bodies known as proteins.

Fats and carbohydrates are used simply as fuel for the body, and as the result of their combustion, heat and energy are generated. Both ultimately produce end-products which are removed from the body largely in the expired air as water and carbon-dioxide. Proteins also supply heat and energy, but they are used for another purpose as well; they form the bricks for building up the waste tissues of the body. That part of the protein molecule which is not required for the renewal of waste tissue is utilised for the production of heat and energy, just as in the case of fats and carbohydrates.

If we endeavour to follow the course of carbohydrate metabolism in the body, we are at once presented with many difficulties, but a few main features are fairly clear. It is certain that starch, no matter in what form it is taken in, is broken down in the intestinal canal by enzyme action into the simple sugar known as glucose. This glucose is then absorbed into the blood, and before getting into the general circulation, passes through the liver. If a great deal of glucose is present, the liver stores part of it for future use, and thus prevents an excessive amount of glucose from being present in the blood at one time. The storage substance which the liver forms from glucose is a starch-like body known as glycogen. Though the chief depot for glycogen is the liver, a good deal is found in the muscles as well. This glycogen is gradually converted into sugar again in response to the requirements of the body, so that a certain amount of sugar is always available for oxidation by the tissues. There is now a good deal of evidence that another storage product besides glycogen is formed during sugar metabolism—the lactacidogen of Embden—but it is doubtful whether this substance, which appears to be of the nature of a compound of sugar and phosphoric acid, ever gives rise to sugar again in the muscles after it is formed. When sugar reaches the tissues it is burnt up and forms carbon-dioxide and water. Many investigations have been carried out in an endeavour to find the intermediate substances between these end products and the larger sugar molecule, but of this phase of metabolism we know nothing with certainty.

Fat is also acted on by the intestinal juices and absorbed as free fatty acids and glycerin; it is largely stored as fat in the body. Before final oxidation, fat is broken down into a lower four-carbon fatty acid—oxybutyric acid—together with diacetic acid and acetone. These substances are then oxidised, forming the usual end-products, carbon-dioxide and water.

It is probable that both fat and carbohydrate have a definite and separate mechanism for metabolism, but that protein, on the other hand, does not possess a separate mechanism. When tissue waste is restored, the remaining protein is broken down into substances similar in nature to the intermediate products of sugar and fat metabolism, which are probably oxidised by the same mechanism as is used for fat and carbohydrate.

[1] Discourse delivered at the Royal Institution on March 28.

Metabolism in Diabetes.

In diabetes the carbohydrates are as usual hydrolysed to glucose in the intestinal tract, but after absorption the glucose tends to accumulate in the body, with the result that a certain amount of it is excreted in the urine. This excess of sugar in the body in diabetes depends on two causes. In the first place, the liver and muscles are unable to store the excess of sugar as glycogen, while in the second place, the tissues have lost to a great extent the power of oxidising sugar. The consequence is that a great deal of glucose is always present in the blood, resulting in a great waste of sugar through the kidneys. It is an interesting fact that one of the earliest manifestations of diabetes appears to be a lack of power on the part of the liver to store sugar as glycogen. This difficulty may be in evidence long before any symptoms of diabetes manifest themselves. In severe cases, oxidation of the sugar is also markedly interfered with, a phenomenon which depends on a lesion of the pancreas; this defective oxidation is most marked in the later stages of very severe diabetes. Generally speaking, sugar passes into the system of the diabetic and is largely passed out again without being utilised. Why this should be so is at present unknown, though various suggestions have been made.

The chemical researches of Fischer and of Irvine have demonstrated the existence of a more active form of glucose than the ordinary variety found in diabetic urine, and it has been surmised that this more active γ-glucose might be the form which the body requires for metabolism. If the body can utilise glucose only after it has been changed into the more active form, it is obvious that a defect in the mechanism responsible for this change would result in a condition similar to what we have in diabetes. The body would be supplied with a variety of sugar which it could not metabolise, with the result that this sugar would be excreted in the urine like any other foreign body. Attractive as this theory appears, it must be admitted that, so far, no convincing evidence of the existence of γ-glucose in the body has been advanced.

With regard to the metabolism of fat in diabetes, it appears that the breaking down of the large fatty acid molecule goes on as usual to the stage of ketone bodies, but that these bodies fail to be oxidised; they therefore accumulate in the blood and are largely excreted in the urine.

As already explained, the oxidation of protein probably takes place partly along the path of carbohydrate metabolism, and partly along the path of fat metabolism. The result is that protein may give rise to both sugar and ketone bodies in the diabetic urine, about 60 per cent. of the amino acids of protein being capable of forming sugar, while 40 per cent. may be excreted as ketone bodies.

The total result of these changes in metabolism is that the urine of the diabetic subject frequently contains large amounts of glucose together with oxybutyric acid, diacetic acid, and acetone.

The diagram (Fig. 1) indicates roughly what happens in metabolism in both the normal and diabetic person. These observations make it clear that no change in the particular class of food-stuffs taken will necessarily result in the elimination of sugar and ketone bodies from the urine.

Blood Sugar Changes in the Normal and in the Diabetic Subject.

Some knowledge of the physiological changes which the blood sugar concentration undergoes in the body is essential in the study of diabetes. In the normal subject, when the blood is examined two or three hours after a meal, it is found to contain about 0·1 per cent. of glucose. As a rule the blood sugar does not sink appreciably lower than this in ordinary circumstances. After the ingestion of carbohydrate food, however, it rises to a maximum of about 0·16 to 0·18 per cent. and then quickly falls to the former level of about 0·1 per

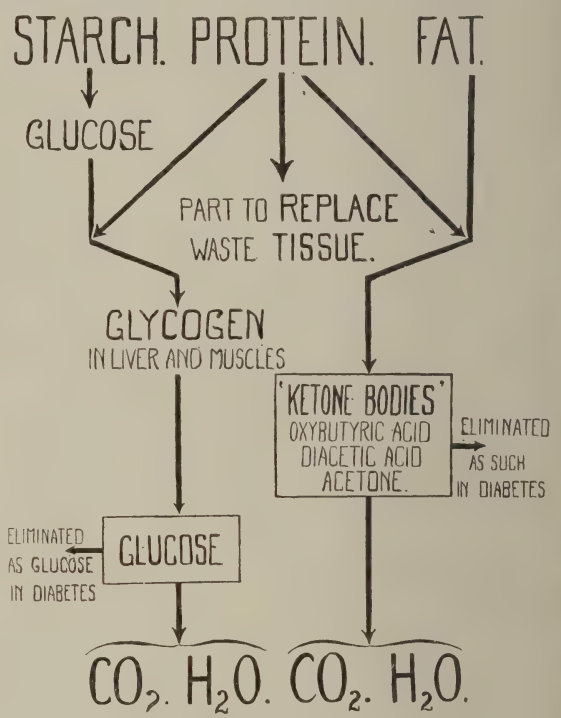
STARCH. PROTEIN. FAT.
GLUCOSE
PART TO REPLACE WASTE TISSUE.
GLYCOGEN IN LIVER AND MUSCLES
'KETONE BODIES' OXYBUTYRIC ACID DIACETIC ACID ACETONE.
ELIMINATED AS SUCH IN DIABETES
ELIMINATED AS GLUCOSE IN DIABETES
GLUCOSE
CO_2. H_2O. CO_2. H_2O.

Fig. 1.—Metabolic paths of food-stuffs in the body.

cent. Usually the maximum rise takes place within one-half to three-quarters of an hour after a meal, and generally the blood sugar content is found to be normal in about one and a half to two hours. These changes are best observed after a meal consisting of from forty to fifty grams of glucose. It might be thought that the early rise just described is due simply to increased absorption of sugar into the blood and that the fall towards the normal level merely indicates that absorption is complete. This is by no means the case, as can easily be shown by experiment. Indeed, it would seem that absorption of sugar may be going on just as rapidly after the blood sugar falls to the normal level as it was when the blood sugar was at its maximum.

The explanation of the phenomenon appears to be that, after some absorption of sugar into the general circulation has taken place, a special mechanism comes into action which stores the sugar as glycogen and so reduces the amount in the blood; this mechanism

resides chiefly in the liver. In connexion with this storage action it is interesting to observe that it is generally quite impossible to raise the blood sugar concentration beyond 0·18 per cent. or so. No matter how much sugar is taken, no greater quantity than this will be found in the blood. Whenever the concentration reaches this point, the liver storage mechanism becomes so strongly developed as to prevent any further rise. The interest of this observation lies in the fact that whenever the blood sugar rises above 0·18 per cent., the kidney begins to excrete sugar in the urine. Until this concentration is reached no sugar is excreted. The difficulty of raising the blood sugar beyond 0·18 per cent. or so indicates that glycosuria in the normal subject should be very difficult to produce as the result of ingesting large amounts of sugar, and experiments show that no sugar appears in the urine of the healthy subject however much sugar he eats.

From these statements it will be clear that the presence of sugar in the urine indicates that the blood sugar concentration is in the region of 0·18 per cent. or higher. Though the normal kidney does not excrete sugar until this concentration is reached in the blood, it sometimes happens that the kidney may leak and allow sugar to pass into the urine when the concentration in the blood is much lower than the figure given. This condition, which is fairly common, is known as renal glycosuria ; obviously it has nothing whatever to do with diabetes. It gives rise to no symptoms and produces no bad effects.

In diabetes the glycosuria is always due to an increased amount of sugar in the blood—a hyperglycæmia—and the changes in blood sugar concentration after eating starch or sugar are very different from those in the normal subject. If fifty grams of glucose are given to a diabetic subject, the rise in blood sugar is much higher than in the normal, and it continues high for a much longer period. Generally, of course, it happens that the blood sugar in the diabetic is much higher to begin with than it is in the normal subject, but it may often be reduced by appropriate dieting to the region of 0·1 per cent., and when this is done and sugar is taken, the blood sugar soon shoots over the 0·18 per cent. mark and often reaches 0·3 per cent. or more, at which high level it may remain for hours. The curves in Fig. 2 represent the effect of 50 grams of glucose on the blood sugar of a normal and a diabetic subject. It is interesting to note that the only sugar which does not raise the blood sugar in the normal subject is lævulose ; in the diabetic, however, lævulose acts just as any other sugar. An appreciation of these facts is necessary in order to understand the action of insulin.

Glycosuria not Diabetes.

Though glycosuria constitutes an important symptom of diabetes, it must be clearly understood that the finding of even large amounts of sugar in the urine does not necessarily mean that diabetes is present. When glycosuria results from a leakage of sugar through the kidney, the condition is obviously of little or no importance, as already explained. Temporary glycosuria is not infrequently produced as the result of such conditions as mental excitement and fear. The explanation that has been suggested by physiologists to account for the increase of blood sugar caused by fear, is, that under primitive conditions some degree of fear was generally a preliminary to active muscular exertion of a defensive nature, and that the sugar was provided as fuel for the production of the required energy. Again, it is very common to find sugar in the urine of students after an examination. An interesting observation bearing on this point was reported some years ago by certain American observers. They examined the urines of a number of male students after an examination and found sugar in 18 per cent. of them. On extending the experiment to female students, contrary to expectation, no such result was in evidence, but since these latter students were all much younger than the males, it is probable that the irresponsibility of youth rather than any fundamental lack of emotion

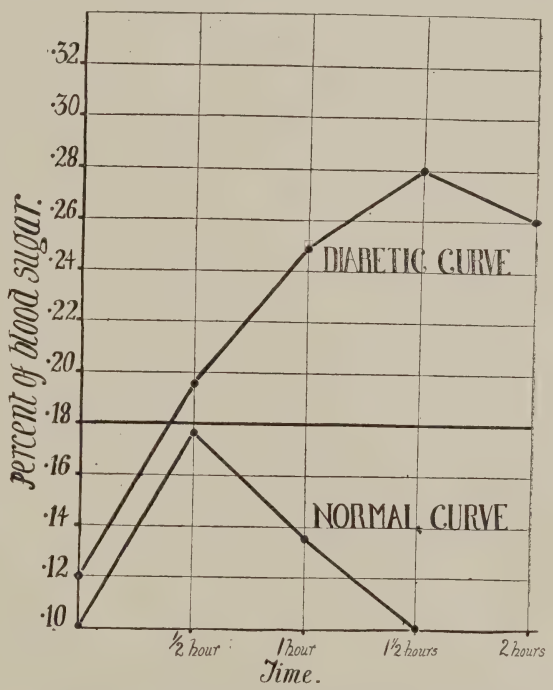

Fig. 2.—Curves of blood sugar concentration obtained from a normal and a diabetic subject after giving each 50 grams of glucose by mouth.

was the cause of the difference. Glycosuria also appears as the result of taking various drugs, and is not very uncommon in elderly patients who practise the belief so widely prevalent that rejuvenation and restoration of bodily and mental vigour may be obtained by the ingestion of large amounts of thyroid gland extract. Another cause of glycosuria not infrequently encountered is the excessive use of alcohol. After long dinners in which alcohol may play but a moderate part, glucose is frequently found in the urine on the following day. All these conditions are dependent on a temporary hyperglycæmia, but they disappear whenever the condition giving rise to them is removed. This glycosuria must not be regarded as of a diabetic nature.

Chief Symptoms of Typical Diabetes.

Along with the blood and urine changes described above, the diabetic suffers from general weakness,

marked emaciation, great mental depression, thirst, hunger, and a very great tendency to the onset of a most serious condition associated with drowsiness and ultimately resulting in unconsciousness and death; this latter state is the fatal condition known as diabetic coma. It is liable to appear sooner or later in every case of severe diabetes, and apart from accidental complications, is the usual cause of death in the diabetic subject.

Though this is the general course in typical diabetes, it must be admitted that the progress of the malady varies much in different individuals, and that many varieties of the disease, from a chronic slowly progressive type to what might almost be called fulminating diabetes, are encountered. Before the advent of insulin it was quite the exception for a patient suffering from well-marked diabetes to live for more than five or six years, though sometimes this period could be extended by careful dieting. This class of case is easily recognised and represents typical diabetes mellitus.

Another variety of so-called diabetes is by no means uncommon in middle-aged and elderly individuals. The patient may feel quite fit, or more frequently he complains of being somewhat out of sorts, with weakness of the limbs and a feeling of tiredness and lack of energy. On examination of the urine a large amount of sugar is found, but no ketone bodies are present. Unlike the true diabetic, there is no emaciation; indeed such a patient frequently tends to get excessively fat. The presence of this condition is not incompatible with the enjoyment of more or less good health for very many years during which sugar is continually passed, and frequently there does not appear to be any progressive tendency on the part of the disease. In such cases there is no danger whatever of coma intervening, and it is obvious that the condition differs essentially from that of true diabetes. Indeed, the patient is not really suffering from diabetes at all, but from a well-marked and persistent glycosuria; his urine contains none of the toxic metabolic products characteristic of diabetes.

What happens in this type of case is that the liver has to a large extent lost the power to store sugar as glycogen, with the result that there is constantly a more or less excessive amount of sugar present in the blood, giving rise to glycosuria. Unlike what occurs in true diabetes, where a definite defect in the pancreas is present, there is here apparently no difficulty in oxidising sugar or fat in the tissues, hence the absence of ketone bodies in the urine. The constant excess of blood sugar probably stimulates the pancreas to produce more insulin, with the result that a good deal of this sugar is stored as fat in the same manner as the diabetic patient treated with insulin tends to put on fat. Occasionally, though not very frequently, this type of persistent glycosuria develops after many years into a true diabetes. This somewhat rare contingency appears to depend on the fact that the large amount of blood sugar constantly present stimulates the pancreatic cells to an over-activity which sometimes results in exhaustion. While true diabetes is probably always associated with a pancreatic lesion, the type of so-called diabetes just described appears to be dependent on a disturbance of the liver. Though, in true diabetes, the liver also fails to store sugar, yet this is but one part of the condition; the most important point is that oxidation of sugar and other foodstuffs is defective. In the glycosuria of elderly individuals the defect appears to be limited to the liver.

The Cause of Diabetes.

The older observers appear to have been impressed by the frequency with which patients dying from diabetes showed definite lesions in the pancreas, and the older literature contained many statements emphasising this point. It was not, however, until 1889 that the relationship of the pancreas to diabetes was definitely established. In that year, von Mering and Minkowski, in an epoch-making paper, showed that the removal of the pancreas from an animal resulted in a condition which was practically the same as severe human diabetes. Removal of part of the gland might or might not produce glycosuria according to the amount of healthy tissue left behind, but complete extirpation was followed in every case by intense symptoms and a fatal termination in coma within a few weeks. Evidence was obtained that this result was not dependent on the loss of the ordinary pancreatic tissue, and it is now generally accepted that certain small islands of special cells found in the pancreas—the Islets of Langerhans—are connected with carbohydrate metabolism and that their destruction or removal results in diabetes. These important experiments constitute the foundation on which all subsequent advances in our knowledge of diabetes, including the discovery of insulin, are based.

Attempts to obtain Pancreatic Extracts for the Treatment of Diabetes.

The discovery that destruction or removal of the pancreas in animals gave rise to diabetes at once suggested the idea that this disease might be successfully treated by giving pancreas or pancreas extract to the patient. It was obvious that the pancreas must contain some active principle which was necessary to prevent diabetes, and the natural inference was that if this substance could be supplied to the diabetic, the symptoms of diabetes would disappear. At first, fresh pancreas or various extracts of the gland were given by mouth, but without any apparent effect. Later, various special preparations were tried by injection, but the results, though by no means always negative, were variable and unsatisfactory. It may with confidence be said that practically every investigator interested in diabetes has at some time or other tried the effects of pancreatic extracts.

It soon became clear that no effect whatever was produced when the preparations were given by mouth, but several observers had quite marked results when hypodermic or intravenous administration was used. Thus, for example, Zuelzer in 1908 prepared an extract which he injected into diabetic patients, with the result that, though no change was made in the diet, the sugar and ketone bodies previously present in the urine were much reduced or, indeed, in some cases disappeared altogether. At the same time the patients improved in general health. The method was, however, given up on account of the frequency with which injections were followed by more or less serious disturbances in the patients, some of whom became very ill, while others showed high fever, rigors and prostration. Zuelzer's product was prepared from the pancreas by

the use of alcohol. He assumed that the active principle was easily destroyed by the pancreatic ferment, and took the view that this might be prevented by treatment with alcohol. Later, Scott, working in America on somewhat similar lines, obtained a preparation which was definitely active though rather weak and inconstant. Various observers had somewhat similar experiences, but nobody was able to prepare a trustworthy non-toxic substance for clinical use in diabetes, and a few years ago it seemed as if the problem was insoluble. The disappointing results of so many investigators tended to substantiate the impression that further work on the problem was not likely to produce results, and our earlier hope of being able to treat diabetes successfully by pancreatic extracts had to a large extent vanished.

This was really the position when Banting took up the subject. Banting adopted the view propounded by many earlier investigators that the trypsin of the pancreas destroyed the internal secretion or hormone necessary for normal carbohydrate metabolism, and that the failure to obtain an active substance depended on this digestive action of trypsin. The difficulty was to devise some means by which this destructive action of trypsin during extraction of the pancreatic tissue could be avoided. It was well known to physiologists that the ordinary pancreatic tissue which secretes enzymes for the digestion of food underwent degeneration after ligature of the pancreatic duct, while on the other hand the islets of Langerhans were not affected. Banting therefore tied the duct in an animal and after several weeks removed the degenerated pancreas. If the theory mentioned was correct, an extract of this pancreas should contain an active substance for the treatment of diabetes since no digestive enzymes would be present. This actually proved to be the case, for a simple saline extract of this pancreas when injected into a diabetic animal lowered the blood sugar and reduced the amount of sugar passed in the urine.

This result was exceedingly interesting, but its practical application on a large scale was obviously impossible. Fortunately, however, it was soon found that the initial tying of the duct was unnecessary, for further experiment on the lines of Zuelzer's work showed that quite active preparations could be obtained from the normal pancreas. Ox pancreas was macerated as soon as possible after the death of the animal and left standing for several hours in 95 per cent. alcohol. The mixture was then filtered and the clear fluid obtained evaporated to dryness by means of a current of warm air. The residue was then dissolved in saline and used for injection. To this active substance Banting gave the name "Insulin."

It is not quite certain whether Banting's original view is correct, but this is of little importance from the practical point of view. Banting's success was largely dependent on the ease with which blood sugar can now be estimated, for it was essential in judging of the effect of insulin on animals that blood sugar estimations should be carried out at frequent intervals. Some years ago this was practically impossible, but now blood sugar may be estimated in the same animal every few minutes if necessary. To Banting belongs the credit of having prepared an active extract of pancreas suitable for the treatment of diabetes, but it must not be forgotten that this great achievement was rendered possible only by the laborious work of many earlier observers. Banting's final triumph was no doubt largely brought about as the result of modern developments in biochemical methods, but, taking everything into consideration, it still remains a mystery why insulin was not isolated many years ago.

As was the case with all former investigators, Banting's earlier products frequently gave rise to more or less alarming symptoms when injected into patients, so attempts were made to obtain a purer substance. These attempts were successful, and samples of insulin were soon prepared which possessed little or no toxic effects. The present method of manufacture depends on the isolation of a crude product by fractional precipitation of pancreatic extract with alcohol; this impure body is treated with picric acid, and insulin picrate precipitated, from which a fairly pure substance suitable for clinical work is obtained. This method requires the use of large amounts of alcohol and is somewhat tedious and expensive; also, it takes several days to complete the extraction and preparation of the insulin. Quite recently, Dodds, at the Middlesex Hospital, worked out a process for the isolation of insulin which possesses many advantages over the usual method in vogue. The principle of this method is based on the earlier observation by Dudley, that insulin could be most conveniently separated as the picrate. In the modification suggested by Dodds, the fresh pancreas is thoroughly ground up with solid picric acid, thus converting the insulin directly to picrate and so reducing the time during which tryptic action may occur. By this process the old tedious filtration of the alcoholic extract is rendered unnecessary. The pancreas-picric acid creamy mixture is treated with acetone, which dissolves out the insulin picrate. The picrate is then purified on the usual lines. Not only is this method more expeditious, but also it actually gives a higher yield of insulin.

Standardisation of Insulin.

The effect of insulin in reducing the blood sugar is not confined to diabetic animals, for it reduces the blood sugar of normal animals as well. This effect of insulin is used in the standardisation of the product for clinical use, and the present unitage is based on the dose required to reduce the blood sugar of a normal rabbit to about 0·04 per cent. An average dose for a diabetic patient is 10 units, but the amount given depends on the gravity of the condition.

Symptoms produced by Insulin.

In both the normal and the diabetic individual, insulin may produce definite symptoms when given in excess. The chief of these symptoms are hot flushes especially on the face, weakness of the limbs, giddiness, sweating, tremulousness, and ultimately, if the condition is not relieved, convulsions, coma, and death. This property of insulin makes the remedy a very dangerous one unless great care is used in its administration, and no doubt explains many of the difficulties encountered by the earlier investigators.

The occurrence of these clinical phenomena is associated with the action of insulin in reducing the blood sugar. When the blood sugar gets too low, the fact

is indicated by the appearance of these symptoms, but it is now certain that patients differ greatly as to the exact blood sugar concentration that may be present when the symptoms come on. Taking the normal resting sugar as about 0·1 per cent., it would seem that in certain subjects, even a slight decrease to about 0·08 per cent. or so may be associated with insulin symptoms, while, in others, the blood sugar concentration may be so low as 0·05 per cent., and yet the patient may feel quite well. In a general way, it is now established that the train of symptoms induced by insulin do not appear when the blood sugar is normal or above this level, but that they are liable to manifest themselves whenever the blood sugar sinks to a sub-normal value; the exact level at which they appear depends on some unknown factors present in the patient. The association of these insulin symptoms with a more or less lowered blood sugar concentration—a hypoglycæmia—is, however, so pronounced that they are generally referred to as hypoglycæmic reactions. It may be taken for granted that when insulin symptoms do come on, the lower the blood sugar the more severe are the symptoms likely to be. Fortunately, these symptoms are very soon relieved if some glucose is taken, so that, generally, this insulin hypoglycæmia is not dangerous, provided that the patient is warned as to the nature of the symptoms, and takes glucose immediately they come on. In certain circumstances, however, the condition may be a very real danger, as every one who has treated many patients must have found.

The curious variation to the influence of insulin which exists in normal individuals is well shown by the results of an experiment carried out in my laboratory on two young healthy medical men each about the same build, age, and weight. For a day or two before the test, both subjects took the same amount and the same kind of food. On the morning of the experiment each received 50 grams of glucose by mouth, and shortly afterwards 20 units of insulin were injected hypodermically. Samples of blood were then taken at frequent intervals for blood sugar estimations. One subject showed no symptoms whatever after the insulin, while the other developed symptoms so severe that it was difficult to get blood for sugar estimations. A further 50 grams of glucose given by mouth had a marked but only a temporary effect in relieving these symptoms, so that very soon the condition was as severe as before and indeed somewhat alarming. A further 60 grams of glucose was then administered with the result that the insulin phenomena passed over once again, though some slight symptoms reappeared later. So far as blood sugar concentration was concerned, there was little difference between the subjects; in both the blood sugar fell to the region of 0·07 to 0·08 per cent. The description of his symptoms given by the subject who suffered from insulin symptoms was as follows: "The first noticeable symptom was profuse sweating of the face, scalp, and neck. This was very quickly followed by inability to perform fine movements with the hands, and weakness of the legs, which, however, was only noticed when standing up. General symptoms were dizziness, and an impression as of all near objects being far away and having a swaying movement. On recovery after glucose, the sweating, dizziness, and swaying sensations were the first to go; the sense of weakness in the limbs remained for the longest time."

In the treatment of insulin hypoglycæmia, there is no difficulty in administering sugar provided the patient is still conscious; on the other hand, when the patient is unconscious, it may be very difficult indeed to get sugar into the system. In such cases the patient may generally be brought round by the injection of 1 c.c. of 1 in 1000 adrenalin solution. A dose of pituitrin (1 c.c.) given subcutaneously will also produce the desired result. If, however, consciousness is not soon restored by these methods, glucose must be injected into the circulation through a vein. This procedure never fails to bring the patient round, provided the hypoglycæmic condition has not lasted too long.

Though severe hypoglycæmic phenomena with unconsciousness were observed fairly often some time ago when our knowledge of the action of insulin was very limited, they are very seldom encountered at the present time, and should never ensue when the use of insulin is founded on a correct perception of its action and properties.

The Use of Insulin in Diabetes.

From what has already been said, it is obvious that insulin does not cure diabetes. Insulin merely replaces a missing substance in the body of the diabetic, and so long as a suitable dose of insulin is being administered, the patient is free from symptoms and feels well both physically and mentally. When the administration of insulin is stopped, the old symptoms reappear. In a typical case of diabetes the results produced by insulin are frequently dramatic. From being a weak, depressed, emaciated wreck, the diabetic very soon becomes a strong, energetic individual. The sugar and ketone bodies disappear from the urine, and there is nothing to indicate that the patient had ever been the subject of diabetes.

Suggestions have been brought forward in some quarters that the vigorous use of insulin may so rest the pancreas that a great improvement in tolerance may be established, and that in some cases a cure may be effected. In my opinion, there is no basis for this expectation, and it is unlikely that insulin will do more in this direction than will a carefully regulated diet. There is a feeling among the public that once insulin is used, it must be administered permanently, for it is believed that the condition of the patient who stops taking insulin is worse than if he had never begun it. This, however, is not so, for a patient may cease to take insulin and be no worse than he was before. Insulin is given by hypodermic injection, the average dose being from 10 to 20 units twice daily. It is usually injected about a quarter to half an hour before food, and is given in the morning and at night, before breakfast and dinner respectively.

One of the most important points in the use of insulin is that the diet should be carefully correlated with the insulin dosage. As a rule, one unit of insulin will "look after" about two to three grams of carbohydrate, so that it becomes most important that an excessive amount of food should not be taken. It is just as necessary for the patient on insulin to follow definite rules as regards food, as it is for the diabetic patient who is being treated by diet alone. The only

difference is that the insulin patient can take a more liberal diet. Once the diet is fixed, it must be adhered to, for a difference in diet would necessitate a difference in dosage of insulin, with the result that at one time the patient might be passing large amounts of sugar, while at another time the insulin might be in excess in relation to the diet, and the patient might suffer from the insulin symptoms already described. I have seen a patient who was taking a fairly large dose of insulin (20 units twice daily), but paying no attention to his diet, pass into diabetic coma.

Insulin and Pancreatic Preparations given by Mouth.

Insulin has practically no effect in lowering the blood sugar when given by mouth; the reason for this is that insulin is very easily destroyed by the ferments present in both the stomach and intestine. These ferments produce their injurious action very rapidly, so that insulin is destroyed before it can be absorbed. Various attempts have been made to give insulin by mouth in association with some substance known to undergo very rapid absorption, and, in this connexion, claims have been put forward that when insulin is taken in alcohol a fair amount of it is absorbed and produces, to some extent, its usual effect of lowering the blood sugar. These claims, however, have not been generally substantiated.

At present there are numerous pancreatic preparations on the market for which the claim is advanced that when taken by mouth they relieve the symptoms of diabetes. It is not always quite clear whether the vendors of these preparations claim that their products contain insulin, but since insulin is destroyed in the alimentary tract, it is obvious that any such claim is of no importance, for even if these preparations did contain insulin, they would be of no therapeutic value when taken by mouth. It is conceivable, however, that pancreatic preparations given by mouth might exert a beneficial action on diabetes apart altogether from the action of insulin. With the view of investigating this point I have tried nearly all the well-known preparations of this kind on the market. So far as my observations go, it would seem as if all these products given by mouth are of no value whatever in the treatment of diabetes.

Some Difficulties accompanying the Use of Insulin.

Naturally, the injection of insulin two or three times a day causes some physical discomfort, but when sharp fine needles are used this is not an important feature, and patients do not mind the slight pain of the injection. Sometimes there is a definite local reaction which may give rise to marked swelling and redness at the site of injection. This reaction generally persists for about twenty-four hours, after which it gradually disappears. As more experience in the manufacture and purification of insulin is gained, these local reactions appear to be less and less frequently encountered, and at the present time no great amount of trouble is experienced on this account. Sometimes, especially during the early stages of insulin treatment, the legs begin to swell somewhat, but this soon disappears.

Continuous administration of insulin over long periods tends to produce a hardening of the skin around the site of injection, so that after some months, a large area of the arm or leg may be markedly indurated. By varying the site of injection, and using different parts of the body, this difficulty may be largely overcome. It must be admitted, however, that the continuous administration of insulin to children is not always an easy problem, for the available surface for injection is not very large, and the skin of both arms and legs sometimes becomes so hard that it is difficult to insert the hypodermic needle. It is usually found that adult patients can inject themselves quite satisfactorily. On the whole, injection of insulin when carefully done does not give rise to so much difficulty as might perhaps be expected, but, on the other hand, there is no doubt that the advent of an effective preparation that could be given by mouth would be a very great practical advance in diabetic therapy.

Diet in Insulin Therapy.

In order to obtain the best results from insulin, it is necessary to put the patient on a special diet containing but a small amount of carbohydrate, the rest of the diet being made up of protein and fat. The amount of food required by a diabetic patient varies according to many conditions such as age, weight, and the amount of work done. It is now customary to express dietetic values, not by the weight of material consumed, but in terms of heat value or calories.

For practical purposes it may be accepted that 1 gram of protein or 1 gram of carbohydrate is equivalent to 4 calories, while 1 gram of fat is equivalent to 9 calories. Now a patient requires roughly a diet that will contain from 10 to 15 calories for each pound he weighs. Thus a patient weighing 140 pounds would require a diet containing from 1400 to 2000 calories, or he would probably do quite well on a diet containing about 1700 calories. In ordinary circumstances, he would no doubt consume considerably more than this. It is essential that the diet should contain some protein, and 0·5 gram or somewhat less for each pound the patient weighs is generally required. Since the carbohydrate allowance is necessarily small, insulin diets usually contain a fairly large amount of fat. Carbohydrate should, if possible, be given in moderate amount, for it ensures safety in the use of insulin, especially during the earlier stages of treatment, and makes the diet more palatable.

Prevention of Insulin Symptoms.

Since insulin symptoms do not come on until the blood sugar is reduced considerably below 0·1 per cent., it follows that no such symptoms are ever in evidence so long as the diabetic passes even a very small amount of sugar in his urine. Some medical men give just sufficient insulin to keep the urine almost but not entirely free from sugar, and thus guard against the onset of any insulin symptoms. Where facilities for blood sugar estimations are available, it is best, however, to give sufficient insulin to reduce the blood sugar to about the normal level.

Though some failures in the use of insulin have been recorded, it is my experience that this remedy never fails to act in typical diabetes; whereas, if the patient is suffering from some other malady as well as diabetes, good results cannot always be expected.

Mode of Action of Insulin in Diabetes.

Insulin very soon reduces the blood sugar in diabetes and eliminates glycosuria even in some patients when comparatively large amounts of carbohydrate food are taken. Strange as it may seem, it appears to be definitely established that the sugar which disappears from the blood as the result of insulin injection does not form glycogen. In rabbits fed on carbohydrate and treated with insulin, little or no glycogen is present, while in well-fed ordinary rabbits not treated with insulin, large amounts of glycogen are found. It is, therefore, obvious that the carbohydrate metabolism of the normal individual may be different in degree at any rate from that which obtains in the patient whose metabolism is helped by the use of insulin.

One of the most impressive features of the insulin patient is the extreme tendency to put on fat. Experiment shows that the sugar which has disappeared does not form fat *directly*, though there is little doubt that it does so indirectly. If we accept the view, which appears to be fairly well established, that insulin does not form glycogen from sugar and does not *immediately* and *directly* form fat from sugar, we are confronted with the problem as to what does happen to the sugar. Increased combustion will not account for the disappearance, so part of it must be stored in some form in the body. There is a good deal of recent evidence that some of it, at any rate, is stored in the body as a combination of glucose and phosphoric acid—Embden's lactacidogen—for experiment seems to show that insulin increases the amount of this substance in the body. Very probably this complex represents an intermediate product on the way to fat formation. The problem of the action of insulin is, however, far from settled, for insulin has a profound effect on both fat and protein metabolism.

The Future of Insulin Therapy.

That insulin relieves the symptoms of diabetes there is no doubt whatever, but, unfortunately, its action is very liable to be interfered with by such causes as cold, an attack of influenza, a mild gastric upset, or almost any slight departure from normal health. The use of gas for removal of a tooth may cause a similar disturbance. In such cases, patients who were free from glycosuria and progressing satisfactorily may begin to pass large amounts of sugar in the urine, and may even suffer from marked diabetic symptoms. In these patients the dose of insulin must be very largely increased, but the correct dose may be difficult to determine. These interferences with the action of insulin render it necessary to keep patients treated with insulin under careful observation. Again, the fact that injection is necessary for the rest of the patient's life makes the use of insulin tedious and not altogether free from physical discomfort. It is difficult to contemplate children going on for forty to fifty years or more having two injections of insulin daily, and no doubt, in spite of insulin, many diabetic children will succumb to intermittent affections.

It is, of course, too early to say what the ultimate effects of insulin will be in the general treatment of diabetes. There is already a good deal of evidence pointing to the conclusion that some patients become, to some extent, accustomed to its action, so that larger and larger doses are necessary. This necessity for larger doses may only indicate a steady progression of the lesion, but a somewhat similar phenomenon is encountered in normal rabbits, which, when injected on several occasions with insulin, gradually show a markedly decreased response to each administration. Recently, some experimental evidence has been brought forward suggesting that, in normal circumstances, carbohydrate metabolism may be somewhat different from what it is under artificial insulin injection. Thus, when a dog is rendered diabetic by total removal of the pancreas, it is apparently impossible to prolong life *indefinitely* by the use of insulin, though, naturally, the dog can be kept alive by insulin for many months.

It might, therefore, be argued that there may be some cases of human diabetes comparable with the condition in the dog in which no active pancreatic tissue is present. In the ordinary diabetic subject there are, of course, some more or less active pancreatic islets left, and further, there is no evidence that the production of pancreatic digestive ferments is at all interfered with. In the depancreatised dog no pancreatic digestive ferments are present, and so intestinal digestion is markedly upset. It has, therefore, been suggested that the inability to prolong the life of the depancreatised dog indefinitely by means of insulin depends on the absence of digestive ferments, and chiefly on the inability to hydrolyse fat.

While this is a possible explanation, it does not seem to be a very probable one, for it has been shown that the depancreatised dog may apparently be kept alive indefinitely, provided a *very small part* of the pancreas is left behind. If these experiments are substantiated, it is not likely that the absence of digestive ferments plays much part in the depancreatised animal, for the amount of digestive ferment secreted by a very small piece of pancreas would scarcely be sufficient to influence the fat metabolism. Indeed, the evidence available at the present time points strongly to the probability that the pancreas forms another hormone essential for the process of normal carbohydrate metabolism besides insulin, and that unless this hormone is present, insulin alone will not sustain life for a long period.

From the clinical point of view, the above assumptions appear to be strongly borne out, and it appears certain that the use of insulin does not serve as a substitute for the normal mechanism. There are such marked differences between a normal individual and a diabetic under treatment with insulin that it is quite certain that the processes in the normal individual are in some way very different from those occurring in the diabetic individual. On the whole, so far as our present experience goes, it would appear that the average human diabetic patient can be kept alive for long periods by the use of insulin, so that, in the absence of accidental circumstances, the diabetic on insulin treatment may expect to live to a normal average age.

Great as have been the results obtained by insulin therapy, it has not yet provided a substitute for the normal process from the clinical point of view, and much has yet to be achieved. On the other hand, the marvellous success of insulin in the treatment of severe and otherwise hopeless cases of diabetes is one of the most striking triumphs in the whole field of modern therapeutics.

Printed in Great Britain by R. & R. Clark, Limited, *Edinburgh.*

NATURE

SATURDAY, JULY 12, 1924.

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Editorial and Publishing Offices :

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Europeans in the Indian Services.

THE story of the British servants of the Indian Government falls naturally into three periods. In the first period the Britisher (we cannot say Englishman because he was more often Scotch or Irish) usually gave up his native land, adopted India as his country, often took an Indian wife, and had a real chance of understanding the people he ruled. There were then few white women in India.

The transition to the second period was due to improved means of transport. The Britisher in the Indian Service no longer settled permanently in India, and he also normally brought with him a portion of European civilisation in the form of a wife. From the point of view of the welfare of India the change had a number of consequences. These British rulers were now birds of passage and thus had less opportunity and perhaps even less desire to understand the people. The introduction of European civilisation to India increased his separation from the people. The European wife disapproved of the earlier unions and their offspring, and the Eurasian, who might have continued to rank almost as high as the European if the first period had continued, now fell seriously in public estimation. Moreover, the presence of a wife and children was apt to affect the nerves of men who in their absence would have faced any situation with perfect equanimity ; the Mutiny still casts a shadow. But the greatest weakness (a weakness shared with the first period) was the absence of contact between the educational and political sides of the Government. On the educational side the Government was teaching the people respect and admiration for democracy, while on its administrative side it remained a benevolent despotism. So apt a pupil as the Indian could not be expected to refrain from a demand for democratic institutions ; which brings us to the third period.

The Morley-Minto reforms were not effectively in the direction of democratic government, and the third period dates from the Government of India Act of 1919 which gave effect to the Montague-Chelmsford reforms and introduced a degree of representative government under the system called "dyarchy." Under this system government activities fall into three classes :

1. Central services carried out for the whole of India by the Government of India.

2. Services entrusted to the local government acting on democratic lines, that is, entrusted to the governor acting on the advice of ministers responsible to a legislative council (called "transferred services").

3. Services entrusted to the local government on the old lines, the governor acting at his own discretion uncontrolled by the legislative council (called "reserved services").

The setting up of dyarchy inevitably raised certain problems, and it is the solutions to these problems offered in the report of the Lee Commission [1] that we have now to discuss. The problems were in effect (1) how should the staff required to carry out the transferred services be recruited and controlled, and (2) what proportion of Europeans should there be in the personnel of each of the services and how is the necessary number of suitable Europeans to be obtained. The principle of dyarchy gives the reply at once to the first question. The transferred services belong to the local government acting in its democratic capacity, that is to say, the officers are the servants of the legislative council, the orders of which they receive through the governor and ministers; and the appointment and control of the officers who carry out these duties must also be the affair of the governor and ministers acting for the legislative council. Accordingly the report proposes that for the education service, the agriculture service, the veterinary service, and the roads and bridges side of the engineering service, no new appointments should be made on the present terms on which officers hold from the Secretary of State, and that new services should be instituted to be recruited and controlled by the local governments.

Into the problem of the European recruits a number of considerations enter: the fall in the value of money, the question of security of tenure, the prospects of promotion, the comparison of the future and the past in regard to the spaciousness of the European's life, and the interest and importance of his work.

The proposals of the Commission in the matter of security and of the fall in the value of money are of a kind that should enable good men to undertake the work. The question of promotion depends on the relative merits of the European and the Indian in the services. The highest posts of all must be considered as outside the reckoning of the European because under the parliamentary system they will go more and more to Indians. Against this is to be set the fact that a smaller proportion of Europeans are to be recruited, so that the proportion of good posts per European is increased, and if they show themselves better men than their Indian colleagues their flow of promotion should be greater.

The greatest change is in the nature of the duties. The benevolent despot dislikes the change and thinks it will ruin India. He has ruled the Indians all his life on the assumption that they are children and he cannot now look on them otherwise. He is consequently out of place in the new system. Instead of him we need a man prepared to respect the Indian as an adult human being, to sympathise with his desire for parliamentary government, and to teach him to run the parliamentary machine. While this may be a position of less personal grandeur than the benevolent despot enjoyed, it is one of greater human interest, and for the right man it will provide a life fully as attractive as the old. It is also possible that by regarding the Indians as adults with human feeling and a certain degree of judgment, and not as children, the future European servants of the Government may escape from the shadow of the Mutiny which has so overhung their predecessors.

For the purpose of carrying out the recruitment and control of the services that are in the future to hold from the Secretary of State or the Government of India, a Public Service Commission is to be established. It will be both judicial and educational. Its judicial functions will be connected with the disciplinary control and protection of the services while its educational qualifications will come in in relation to recruitment. The appointment of this Commission is a necessary development and was in fact prescribed by the Government of India Act of 1919, and in addition to this central Public Service Commission each province will find it necessary to set up a similar body to manage the recruitment and control of the officers employed on transferred services. This is recognised by the Royal Commission, which states in paragraph 30 "we are aware that any proposal that a central Public Service Commission should be empowered to interfere on its own initiative in provincial administration would be regarded as violating the principle of provincial autonomy."

It is rightly recommended that the knowledge and experience of the Public Service Commission should be placed at the disposal of any local government that chooses to use it. It is highly desirable that the local governments should take advantage of this opportunity, but any self-respecting government will shy off if the attentions of the Public Service Commission are thrust upon it, and yet in paragraph 27(3) the Royal Commission recommends that the Public Service Commission should be the final authority for determining "the standards of qualification and the methods of examination" for the local government services. This recommendation clearly violates the principle of provincial autonomy and cannot possibly be put into force; and the very fact that it is recommended may determine the local governments to have nothing to do with the Public Service Commission.

The truth is that the Royal Commission has given little attention to the machinery of recruitment. Witness the illogical minute on the London Open Competitive Examination which has been thought worthy of publication. Witness also the recommendation that the upper limit of age for the Indian Civil

[1] Report of the Royal Commission on the Superior Civil Services in India, dated March 27, 1924.

Service should be twenty-four, because the universities prefer that age, and the statement that "it was a corollary of the decision to reduce the upper age limit to 23 years that the period of probation for recruits should be extended from one year to two"; the truth being that the basic decision was for two years' probation and reduction of the upper age limit to twenty-three an inevitable corollary. In this connexion we should have expected the Commission to take some account of the fact that a probation of two years is already in force for the Indian Civil Servants recruited in India.

In spite of these blemishes to which we have thought it necessary to direct attention, the fact remains that the Royal Commission has done sterling work towards making the government service attractive to the European. Its work is in the main excellent, and the blemishes can easily be removed.

Southern Nigerians.

Life in Southern Nigeria: the Magic, Beliefs and Customs of the Ibibio Tribe. By P. Amaury Talbot. Pp. xvi + 356 + 32 plates. (London: Macmillan and Co., Ltd., 1923.) 21*s.* net.

"ONLY by the good will of the black men will it ever be possible for more than the faintest idea of his complicated psychology to be grasped by the white; and could but the educated negro be brought to understand that he has infinitely more to gain than lose by recording every scrap of information concerning native customs and beliefs—omitting nothing and concealing nothing—such a book might be written as has never yet seen the light of day." This expression of opinion sums up Mr. Amaury Talbot's whole attitude towards the African. His latest book, "Life in Southern Nigeria," is written not only with knowledge and experience, but also in a spirit of sympathetic understanding. As a guide for future administrators the work is invaluable, combining as it does the results of scientific research with an appreciative knowledge of the beliefs and superstitions of an ancient people.

The Ibibio, of whom the author writes, are a little-known people living in the south-eastern part of Nigeria. They number, in all, more than a million, of whom some hundred and fifty thousand inhabit the Eket district. This is Mr. Amaury Talbot's description of them: "The Ibibio are typical negroes, thick set, with long arms, short trunks, medium-sized legs and feet broad and flat. Their language belongs to the Semi-Bantu group with many and strong affinities to the Sudanic tongue of their neighbours, the Ibo, with whom they have much in common." Although, as the author points out, the march of Western civilisation results in the younger members of the Ibibio becoming Christianised, many of the older generation still cling to beliefs and ways unchanged since the childhood of the world. "For them," he writes, "the commonplace does not exist, each object is tinged with wonder and mystery, while forces benevolent or malignant are to be felt on every hand."

According to Mr. Amaury Talbot there are two forces which influence the life of the Ibibio, the Ndemm (meaning fresh water) and the Ibokk (often translated by Juju as well as by medicine). The first of these forces dwells in or near rivers, pools, springs, and trees. They are gnomes, salamanders, dryads, etc., and are supposed to be male and female. The Ibokk are natural or elemental forces, which do not affect, or come into contact with, human beings until made to by a doctor or "wise" man. An interesting chapter is one on magic plays, where the author describes what may be called conjuring tricks. "A vast concourse of people gather together and a baby is brought into their midst. The child is thrown into a fu-fu mortar and beaten to pulp before the eyes of all the people. Three men are chosen to eat the babe, and when all is eaten, they begin to dance. After a while the central figure shakes his leg violently and from the thigh the child appears."

The idea that the soul of man or woman has the power to leave its human form and enter into that of its "affinity" is firmly held by these people. In proof of this the author relates the story of a Yoruba steward, who was caught by a crocodile one evening and dragged below into the river. After investigation it was found that the crocodile was supposed to contain the soul of a Juju man who, when angered against the Government, wreaked his vengeance on the officials. On this particular evening he was especially incensed against an official who had reported his evil deeds, and waited until he could have his revenge.

There are, according to Mr. Amaury Talbot, three secret societies of the Ibibio, the Egbo, Idiong, and Isong. Their initiatory ceremonies bear a strong resemblance to Freemasonry, and any non-member attending the ceremony would be punished severely. In an interesting chapter entitled social organisation and tabu, the author lays stress on the fact that slaves taken in war were most kindly treated, and in many cases allowed to marry into their masters' family. Amongst the food taboos the animals forbidden were snakes, monkeys, and lizards. In this chapter Mr. Amaury Talbot relates an experience he had whilst District Commissioner. Three of the head chiefs

of Ikotobo came to him one morning trembling with fear, and asked him if it were true that he was going to use tonite for the removal of some tree-trunks which were blocking a certain creek. Mr. Amaury Talbot assured them that no orders had been given to that effect, and demanded the cause of their fear. The answer was as follows: "Deep down in the waters of the creek are tiny houses such as ants make. Near these houses live fishes, with skins as black as our own. In these fishes are the souls of our ancestors, and for every fish you would kill one of our people would die."

Space does not allow one to quote the telling descriptions of bush fires, wide expanses of beautiful scenery, or vast pools of water given in this book. With regard to fire-worship, which still goes on, the author says: "In lands where such demonstrations of the power of fire are matters of constant occurrence, it is not to be wondered at that many rites of fire-worship should here still form part of the race. On a certain day in the wet season some towns, for instance, make two great bonfires, one on each side of the road. Then they gather their cattle, sheep, and goats into a herd and drive them between the walls of flame. This ceremony is said to destroy evil influences which might otherwise have caused sickness to fall upon the beasts during the year, and is also considered to act as a fecundative agent."

Upon realising the spirit in which the author has written this book, one is not surprised to find within its pages a graceful note of appreciation to two most valuable helpers. One is Mr. W. W. Eakin, of the Kwa Ibo Mission, and the other Etubom Nyung Ansa, better known by his English name, Chief Daniel Henshaw, Native Political Agent for the district. "He is," writes the author, "a Chief of pure blood and head of one of the seven ruling families of Calabar, where his ancestors were found in possession on the coming of the early traders."

Although Mr. Amaury Talbot fully realises the vast amount of work still to be accomplished in this part of West Africa, he is not discouraged; for he has an interesting theory regarding the solution of the problems before the administrators. "The darker aspects of many rites and beliefs may be attributed," he says, "in great part at least, to the shadow cast over the minds of the people by that dense tropical forest which covers such vast stretches of the West Coast, or by the mangrove swamps which surround low-lying lands. In open sun-lit country, like the wide plains of Northern Nigeria and the Sudan, the more revolting customs seem to be dying out, as was the case in Egypt with the cutting of the bush, and in Europe with the thinning of the great forests."

Climatology, Objective and Subjective.

(1) *Die Klimate der Erde: Grundriss der Klimakunde.* Von Prof. Dr. W. Köppen. Pp. x+369+8 Tafeln. (Berlin und Leipzig: Walter de Gruyter und Co., 1923.) 7*s.* 2*d.*

(2) *Die geopsychischen Erscheinungen: Wetter und Klima, Boden und Landschaft in ihrem Einfluss auf das Seelenleben.* Dargestellt von Prof. Dr. Willy Hellpach. Dritte, neubearbeitete Auflage. Pp. xx+531. (Leipzig: Wilhelm Engelmann, 1923.) 14*s.*

DEEPLY rooted in the human mind is the instinct to collect "specimens," to classify them and to arrange them in museums. Prof. Köppen is the exponent of this instinct in the domain of climatology; his specimens are data of temperature and rainfall. Some years ago he laid down his system of classification, and now he has completed and arranged his collection. "The Climates of the Earth" (1) is a handbook and guide to the Museum of Climatology. After a general introduction dealing along the usual lines with the objects and methods of the study of climate and the factors which govern the distribution of the climatic elements, we have a full account of the system of classification and notation, followed by generalised and then by more local descriptions of the different types. Finally there are sixty-nine pages of "specimens," namely, the mean and extreme temperatures, the rainfall, and in some cases the cloudiness and humidity for more than a thousand stations.

The results of such a systematic treatment are not difficult to foresee. There is an orderly development of the subject-matter which effects great economy of space. The ordinary political boundaries are ignored; Asia, for example, is treated under four headings, the tropical rain-belt, the dry region, the warm temperate rain area, and the boreal zone. The description is logically complete, and yet occupies only twenty-one pages. There is an even greater triumph of system in the frontispiece map, from which, knowing the notation, it is possible to read off the salient features of the climate of any part of the world with great ease and definiteness. On the other hand, when everything is subordinated to a system, there is no room for details which from the author's point of view are irrelevant. Climatic peculiarities which the visitor might regard as of some importance, such as the mistral of the Mediterranean, are either ignored or dismissed in a brief and colourless sentence. The use of the shorthand notation accentuates this impression of flatness; the statement that the climate of a large region is *Cfb* is no doubt complete and accurate, but until the interpretation becomes automatic, it is irritating

rather than inspiring, especially to the non-German reader who has to deal with contractions in a language not his own.

To sum up, the book gives a clear insight into the causes underlying the distribution of the main climatic features over the globe, and for this reason should be of great value to teachers, who can make use of the excellent arrangement of the material while filling in the details from other sources. The statistician will welcome it for the amount of information it conveys in a small space, but the ordinary reader will find it rather devoid of human interest and picturesque illustration. The author certainly has the courage of his convictions, for while there is a very complete index to the tables, except for the table of contents at the beginning there is no index to the text.

(2) "Geopsychical Phenomena" is a book of a very different stamp. The author is a nerve specialist, whose interest lies in the reaction of man to his natural environment, and from his medical experience he is able to write with great authority on the mechanism of these reactions. For him the basis of a classification of climates is not the mean temperature and rainfall, but the influence on human well-being, especially as exerted through the mind, either by means of the senses or by the general level of health induced. Climates (and also temporary weather conditions) are classed as enervating or bracing, and the instrument of research is not the thermometer or rain-gauge but the "weather man," who experiences these effects to the greatest degree. Thus the book is almost entirely subjective; it is of great human interest, as is proved by its having reached a third edition.

The chief sources of this interest are the vigorous detail and the fact that most of us have experienced in a greater or less degree the feelings described, for example, as accompanying the passage of a thunderstorm. But there is often a lack of definiteness, partly due to the subject-matter, which does not lend itself to exact treatment, and partly because the weather elements which the author regards as most important are not always those about which climatologists have most to tell us. Atmospheric electricity is credited with great effects, while the powers of solar radiation of various wave-lengths are well known, but more data about the distribution of these elements are required before the subject can be treated definitely. Hence the author is not entirely unjustified in blaming meteorologists for a certain inconclusiveness in some of his remarks. An experiment of even greater difficulty and, if possible, of even greater interest, is the attempt to measure the effects of that branch of the environment termed the landscape. The analysis mainly consists of a study of colour and form, and is certainly justified by its importance, but at the present stage a definite measure of the health-value of a landscape is scarcely to be expected.

It is interesting to note that even in such a subject as the "feel" of weather, numerical methods have obtained a foothold. Thus several formulæ are quoted which express the sultriness of the air numerically in terms of the temperature and humidity. None of them is quite successful, but they constitute a beginning. The author does not appear to be acquainted with recent British work on this and allied subjects, owing to difficulty in obtaining the necessary journals.

The book should be of great value to doctors, of interest to meteorologists and geographers, and it has also a strong appeal to the general reader, but only those who read German readily should attempt it. Once again we have to bewail the absence of an alphabetical index, and this time the omission is more serious.

The Teaching of Mathematics in France.

(1) *Cours complet de mathématiques spéciales.* Par Prof. J. Haag. Tome 3: Mécanique. Pp. viii + 190. (Paris: Gauthier-Villars et Cie, 1922.) 12 francs.

(2) *La Composition de mathématiques dans l'examen d'admission à l'École Polytechnique de* 1901 *à* 1921 Par F. Michel et M. Potron. Pp. xii + 452. (Paris: Gauthier-Villars et Cie, 1922.) 40 francs.

(3) *Dynamique des solides.* Par Dr. J. Reveille. (Encyclopédie de Mécanique appliquée.) Pp. 506 (Paris: J.-B. Baillière et fils, 1923.) 40 francs.

MATHEMATICAL teaching in Great Britain, at least in its more elementary stages, makes its appeal to the intuitive faculties of the pupil, and the mathematical and mechanical principles and methods are made as real and immediate as possible. If Prof. Haag's treatises are representative samples of French mathematical text-books, then they indicate that French mathematical teaching aims more at capturing the imagination of the learner and exercising his reasoning faculties in abstract terms. The professor's aim is to provide books for candidates who wish to enter the famous École Polytechnique and the École Normale Supérieure in Paris, and thus the book caters for the better class of pupils from the lycées or secondary schools. The atmosphere of the present book (1), with its emphasis on mechanical principles, is nevertheless highly abstract and theoretical. The treatment is interesting and possesses the elegance we expect from French writers. The author claims that "Un livre de mathématiques ne doit pas se lire comme un roman; plus il exige de travail et de

réflexion plus il est profitable." An English schoolboy would almost certainly read such a book like a novel, especially as in this "Cours" the examples are relegated to separate volumes. The author emphasises the importance of the examples and insists that the student should do a considerable number himself. French pupils can no doubt use such books: the English pupil needs something more concrete—but it would do any English student a considerable amount of good to read Prof. Haag's volume on mechanics, and study his interesting account of the principles of the subject.

This abstract and theoretical character is also to be found in the collection of mathematical questions set at the entrance examinations to the École Polytechnique, and issued with solutions by MM. Michel and Potron (2). The subjects included are algebra with analysis (*i.e.* calculus), trigonometry, geometry, and mechanics. Numerical examples are very rare, being limited apparently to the actual solution of equations. Even the questions on mechanics are very abstract and bear little relation to life, but they seem to test very well the fundamental principles. In each question the examiners suggest a topic or a mode of treatment, with a number of applications: the candidate's duty is to apply his knowledge to the series of questions on this one topic or method. We quote as an illustration *one* "composition" under the caption: Analytical Geometry and Mechanics.

I. On the logarithmic spiral $r = ae^{m\theta}$ take M_0, M defined by θ_0, θ.

(1) Find the centre of gravity G of the arc M_0M.
(2) Find the limiting position of G as M_0 tends towards the pole O.

II. When M_0 is at O, let the polar angle θ of M increase at the rate of 1 radian per second.

(1) Investigate the curve Γ which is the locus of G.
(2) Find completely the velocity V and acceleration A of G for any value of θ.

III. Instead of the spiral consider any curve C. The end of the arc $M_0M(=l)$ of this curve is supposed to move along C according to some given law in terms of the time. Given the centre of gravity G of the arc M_0M, the end M of the arc, the tangent MT at M, the length l of M_0M, the first two differential coefficients (l', l'') of l with respect to the time, find completely

(1) The velocity V of G.
(2) The acceleration A of G.

IV. In the particular case when the curve C consists of two rectilinear segments M_0O, OM

(1) Find the centre of gravity G of M_0M.
(2) Find the locus Γ of G as the segment OM assumes all possible positions round O as a pivot in the given plane.

This should be sufficient to indicate the style of the questions. The solutions are interesting and occasionally elegant.

(3) Dr. Reveille's book is a compromise between the abstract and the practical, as befits a volume forming part of the "Encyclopédie de Mécanique appliquée" issued under the direction of Prof. Lecornu. It combines in a really competent manner the theoretical and the industrial aspects of the subject of rigid dynamics. There is a good account of the motion of a body about a fixed axis, of general two-dimensional rigid dynamics, of the motion of a rigid body about a fixed point including both the Poinsot construction and the elliptic function solution, of the top, of a rigid body on a plane, and of the theory of gyroscopic motion. The whole forms a very good account of the most useful and important parts of rigid dynamics, including the method of Lagrange's Equations applied to holonomic and non-holonomic systems. At the same time the author discusses in considerable detail a large number of practical applications, such as the motion of millstones, the treadmill, the hoop, the bicycle, including looping the loop, and all kinds of gyroscopic methods, such as Foucault's experiment, Brennan's monorail, the motion of torpedoes, and various forms of gyroscopic compasses.

S. BRODETSKY.

Ambroise Paré.

Selections from the Works of Ambroise Paré. With Short Biography and Explanatory and Bibliographical Notes, by Dorothea Waley Singer. (Medical Classics Series.) Pp. iv+246. (London: J. Bale, Sons and Danielsson, Ltd., 1924.) 12*s.* 6*d.* net.

AMBROISE PARÉ (1510 ?–1590), although brought up as a barber surgeon, lived to become the founder of French surgery, one of its shining lights, and one of the greatest military surgeons of all time. He published a great deal during his lifetime, and his collected works appeared in many editions after his death. There must have been a very large number of copies of his works, and yet the earlier ones are excessively rare or even unobtainable in some of the largest medical libraries. Paré's experiences were bought practically in numerous campaigns, battles, and sieges in which he served various French kings against that stormy petrel of the sixteenth century, Charles V. Apart from his practical skill as a surgeon, Paré's name has been honoured in all subsequent ages as the ideal of an honest, modest man of a most humane disposition,

with an intense feeling of sympathy for the wounded soldier gashed by gunshot wounds or arrow-heads. His modesty is summed up in his motto, "Je le pansay et Dieu le guarit."

After the exhaustive work of Malgaigne and the charming work of Stephen Paget it is difficult to give a new view of Paré which is equal to theirs. Mrs. Singer set herself a difficult task, and in our judgment she has not been altogether successful. Her book consists of an introduction of 46 pages, in which the main facts of Paré's life and work are set out, while the rest of the book is a reprint of the English translation which Thomas Johnson made in 1634 from the Latin translation of Paré's "Œuvres" in 1582, by Paré's pupil Jacques Guillemeau. A comparison of the original French with Johnson's translation shows that Paré lost somewhat in his English garb, and it would probably have been better to replace the archaic Johnsonian phraseology by a modern English translation of the sections quoted.

A work like that which Mrs. Singer has attempted really requires co-operative editing in the present state of knowledge. A typical example may suffice. With reference to a case, described and cured by Paré, of a certain Guordon, Seigneur d'Achindon, Mrs. Singer gives a footnote (p. 68) which is almost certainly incorrect. She has been unable, she says, to trace Achindon, but there is no difficulty about this, as Auchindoun was the stronghold of the Huntly family, and still exists as a well-known ruin near Dufftown, N.B. The Guordon of Paré was almost certainly not the person suggested in Mrs. Singer's footnote, but Sir Adam Gordon of Auchindoun—the "Edom of Gordon" of Scottish ballad fame. This gay Gordon, after various adventures at Corrichie and elsewhere, burned the lady of Towie in her castle in 1574 and fled to France, where he was pursued by one of her kinsmen, Arthur Forbes. A most circumstantial account of Forbes's attempt to assassinate Auchindoun will be found in Robert Gordon's "History of the Earldom of Sutherland," 1830, p. 170, and this agrees exactly with the account of the Seigneur d'Achindon of Ambroise Paré. The matter we have referred to is perhaps trivial, but in works on medical history it is well to be accurate.

Our Bookshelf.

The Moon-Element: an Introduction to the Wonders of Selenium. By Dr. E. E. Fournier d'Albe. Pp. 166+8 plates. (London: T. Fisher Unwin, Ltd., 1924.) 10*s.* 6*d.* net.

DR. FOURNIER D'ALBE'S book is chiefly a history of the optophone, the instrument for enabling the blind to read ordinary print. This history claims about one-third of the volume and deals in chronological order with the development of the device from its invention by Dr. Fournier in 1913 to its present form in which Messrs. Barr and Stroud, and, in particular, Dr. Archibald Barr of that firm, have collaborated. The long eighth chapter is a record of the pertinacity of the author for many years in the face of discouragement and opposition, and is almost a biography. Indeed, a not unsuitable title for the chapter, if not for the whole book, might be "The Triumph of the Optophone." It is natural enough that an author should write at length on the fruit of his own efforts. Here, in so small a volume, the effect has been to curtail too much what could have been written about other important applications of selenium. The optophone is the only instrument described in anything like detail. Most of the other selenium devices are referred to only briefly, and a few get no mention at all.

Dr. Fournier is not afraid to speculate; he does so whole-heartedly in more than one place. In the first chapter entitled "Electricity and Light," he gives himself especially free rein when he pictures "the two kinds of electricity as consisting of living beings of sub-atomic dimensions, divided, like the higher animalcules, into two sexes, and living their life on a scale of time and space removed a millionfold from the latter." The inclusion of this first chapter, much of which bears little relation to the scientific treatment of the subject in hand, definitely marks the book as popular rather than technical. Perhaps, indeed, this has been the purpose of the author, although it is not so defined in the preface. His enthusiasm for his subject sometimes displaces the impartiality proper to scientific description, and he would probably be prepared now to admit that his hypothetical and comprehensive condemnation of all selenium cells, save those of his own construction, as expressed in line 24, page 70, is scarcely worthy of an investigator of his own attainments.

In spite of its scientific defects the book is most eminently readable. Dr. Fournier's wide experience as an author in varied fields is a guarantee of that. He has a way with him in writing that grips the reader; the reviewer himself read the book from cover to cover in a single sitting. Dr. Fournier writes with the authority of a recognised expert, and if, as the title rather suggests, he has aimed at arousing the spirit of wondering interest among the general public, he will without doubt succeed. A. O. R.

Pulpwood and Wood Pulp in North America. By R. S. Kellogg. Pp. xii+273. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 20*s.*

THE manufacture of paper from wood pulp began on a commercial scale in 1854, as before that date the raw material ordinarily used was cotton and linen rags, esparto grass, straw, and hemp. The first process of making paper from timber was a purely mechanical one, by which the fibres of the wood, after being torn apart by grindstones under a stream of water, were transformed into so-called "mechanical" pulp, which is still the source of the cheaper kinds of paper. Tilghman in 1867 discovered the disintegrating action of sulphurous acid upon wood; and this formed the basis of the invention of the sulphite process, which was started commercially in Sweden

in 1874. The resulting product, "chemical" wood pulp, is used for the better classes of paper.

The wood pulp industry in a little more than half a century has grown to an enormous extent in Scandinavia, Germany, and North America. This is not to be wondered at, as the consumption of paper is increasing all over the world by leaps and bounds. In 1922 the paper used in the United States for newspapers alone amounted to 45 lb. per head of the population.

Mr. Kellogg gives a detailed account of the pulp industry as it is now carried on in Canada and in the United States. He describes the various processes of manufacture and the different species of woods employed, and gives statistics and charts of costs and production. He deals very fully with the important question of the timber supply now available in North America; and discusses the annual drain on the forests, due to felling for all purposes and loss by fire, insects, and disease. It is estimated that the timber in the United States at the present rate of consumption will last only for sixty-four years. The need for scientific forestry and better modes of protection is urgent in the extreme. The book is well illustrated with diagrams, maps, and reproductions of photographs, which depict forest scenes, pulp mills, and machinery. The view of a nursery in Canada, where five million seedling trees are raised annually, shows that some of the great lumber companies are at last taking active measures to replenish the areas that have been devastated by reckless felling and disastrous fires.

An Introduction to the Theory of Optics. By Sir Arthur Schuster. Third edition, revised and enlarged by the Author and Prof. John William Nicholson. Pp. xv+397. (London: E. Arnold and Co., 1924.) 18*s*. net.

THERE is no need to set out here the merits of Sir Arthur Schuster's book on optics, and in describing the new edition, in which he has had the collaboration of Dr. J. W. Nicholson, we may confine ourselves to the novelties that have been introduced. These include descriptions of some of the newer optical instruments and processes, among them an excellent account of Michelson's method of measuring stellar diameters.

The main addition is in two chapters at the end, which deal with the quantum theory. In the first of them there is a good account of Bohr's theory of the hydrogen spectrum, which is followed by a short discussion of Planck's law of radiation. In this there is an unfortunate misprint, giving preference to Planck's second hypothesis over his first, instead of the other way about. We may also regret the absence of any mention of the thermodynamic principles which should serve as the basis of any discussion of radiation; indeed a detailed discussion of "black body radiation" would be a proper complement to the excellent descriptions of white light that are found earlier in the book. The account of the partition law is adequate, though we may confess a doubt whether a student coming fresh to the subject would find it convincing. However, this objection applies to nearly all presentations of the subject which approach it without a thorough consideration of statistical principles.

The last chapter deals with the dynamical theory of spectra. It follows mainly the work of Sommerfeld and his school, giving the three dimensional quantisation, fine structure, etc., and then Sommerfeld's construction of the formulæ of Rydberg and Ritz. It also contains an account of ionisation potentials and concludes with the dynamical theory of the separation of variables, the principle of adiabatic invariance and the correspondence principle which is applied to the Stark effect. Altogether the whole constitutes a good outline of many of the more recent optical applications of the quantum theory.

James Dewar, 1842–1923: a Friday Evening Lecture to the Members of the Royal Institution, on January 18, 1924. By Henry E. Armstrong. Pp. 32. (London: Ernest Benn, Ltd., 1924.) 1*s*. 6*d*. net.

EULOGY, whether spoken or written, makes greater demands upon judgment, knowledge, and taste than any literary task—so difficult is it, while maintaining equipoise between the elements that compose virility and virtue, to avoid transgression into adulation too fervid or into praise too faint. When eulogy relates, however, to a friend who has passed beyond mortal life, the task is to some writers made easier, for thoughts then spring from the depths in proverbial abundance, and there is more of reverence to steady the balance. It is in these circumstances that Prof. Armstrong pays tribute to his friend James Dewar. He extols the great philosopher in terms the substance of which is already familiar to those who early in the year followed the proceedings of the Royal Institution; but it is well that the discourse then so finely wrought in the rough, and now polished, and set in the gold of generous appreciation, should take this permanent form. Here and there some comparisons may be too vivid, here and there the detail may be weak, and the allusions may occasionally be inconsequent and in excess, but the work as a whole reveals with truth and justice the skill, genius, character, and nobility of purpose of James Dewar, in a manner to encourage and to inspire all who study it in a mood to respond. R. A.

Assyrian Medical Texts: from the Originals in the British Museum. By R. Campbell Thompson. Pp. vii+107. (London: Oxford University Press, 1923.) 42*s*. net.

IN our issue of April 12, p. 529, we published a note on a reprint from the Proceedings of the Royal Society of Medicine by the same author on the same subject. The present work is a series of 107 plates containing the text of 660 cuneiform medical tablets for the most part previously unpublished. They are from the Royal Library of Ashurbanipal, now preserved in the British Museum, and date from the seventh century B.C. It is perhaps to be regretted that the preface is not given in greater detail, as otherwise the work is intelligible only to Assyriologists.

Bell's Card of Logarithms and Science Tables. 10 in. × 8½ in. (London: G. Bell and Sons, Ltd., 1924.) 2*s*. net per dozen.

THIS is a single card of convenient size for use in classrooms, giving four figure logarithms, trigonometrical tables for intervals of one degree, and a number of useful physical and chemical constants.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Liquid Crystals—Soap Solutions and X-rays.

AMONGST the earliest examples of Lehmann's liquid crystals were the transparent double cones of ammonium oleate. MacLennan's work has shown that this transparent anisotropic state is common in soap solutions. The accompanying photograph (Fig. 1), taken by Mr. W. J. Elford in this laboratory at the suggestion of my colleague Mr. Piper and myself, shows the very striking appearance presented by these transparent solutions when examined in slightly convergent light between crossed Nicols. The transparent conic anisotropic liquid shown occurs in 2·5 weight normal potassium laurate at 45° C., magnification 200 diameters, and it exhibits very clearly the characteristic fan-like structure composed of focal lines.

A glance at the photograph shows the aptness of

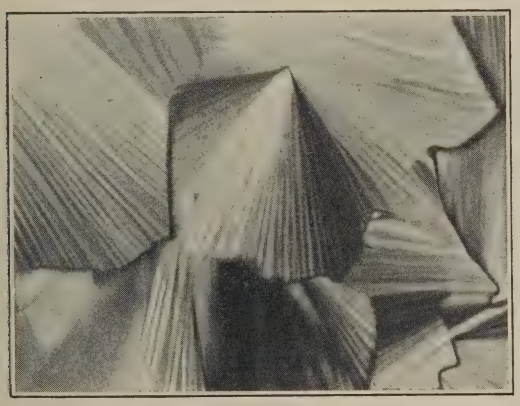

FIG. 1.—2.5 N potassium laurate. Transparent anisotropic plastic phase (40-50° C.). × 200 diameters.

Friedel's designation of this state of matter, namely, "liquide à conique," which he now proposes to supersede by the term smegmatic (smectique) in order to place soap curds in this class. We have found, however, that every aqueous soap such as potassium laurate may be prepared in each of the forms: hexagonal crystals, curd fibres, and anisotropic and isotropic liquids.

Piper and Grindley found a year ago that the curd fibres show an X-ray structure resembling Müller and Shearer's X-ray diagrams for crystals of fatty acid, whereas anisotropic liquids have given negative results. Following Friedel, they ascribed these curds to the "smegmatic condition." Friedel nevertheless expressly states that for any substance there can be only one "smegmatic" form, and that there are no discontinuities in a "smegmatic" specimen other than the apparent focal lines. Now curd fibres are discrete, and they differ greatly in almost every way from the conic anisotropic liquid soap illustrated in the accompanying photograph, which is seen to typify Friedel's "état smectique" or "liquide à conique." It is therefore evident that Friedel's attempt to classify opaque soap curds as "smegmatic" when that state is already filled by the transparent conic liquid soaps would disrupt his classification of liquid crystals and necessitate the *ad hoc* setting up of a new group within which to include such curds.

JAMES W. MCBAIN.

University of Bristol.

Earth Tides and Ocean Tides.

I AM in entire sympathy with Mr. Lambert's plea in NATURE of June 21, p. 889, for further research on earth tides. It is much to be regretted that so little has hitherto been effected in that direction. I only wish our "far-flung" Empire had done its share in investigating geophysical problems connected with the earth's crust. I fancy, however, that the horizontal pendulum would be more easily and cheaply installed in outlying stations than the interferometer apparatus of Michelson and Gale. The Milne-Shaw seismometer can be adapted for the purpose by the addition of a stationary mirror tracing a reference line on the record.

Mr. Lambert refers to the "greater apparent rigidity in the prime vertical than in the meridian . . . in various places near the Baltic Sea." This presumably applies to the horizontal pendulum observations at Potsdam and Dorpat (in Esthonia). He goes on to say that "when various ingenious explanations of this peculiarity were found to be untenable, it came finally to be accepted that the true explanation lay in the effect of the oceanic tides."

At Potsdam, where the inequality of the rigidity in different directions is much greater than at Dorpat, the direction of maximum rigidity is apparently not due east and west but about 8° north of west and south of east. This is approximately parallel to the strike of the later foldings in the older rocks to the south and no doubt also of those covered by the Quaternary deposits in the neighbourhood of Potsdam itself. This folding probably extends some miles down in the earth's crust and must diminish the rigidity in a direction at right angles to its strike. I fail to see why this explanation is untenable.

It would be interesting to ascertain how rigidity varies with direction in the neighbourhood of lines of north and south folding.

JOHN W. EVANS.

Imperial College of Science and Technology,
S. Kensington, S.W.7.
June 28.

The Structure of Molecules in relation to their Optical Anisotropy.

As is well known, the light scattered transversely when traversing a column of gas or vapour is not completely polarised, the defect of polarisation depending on the nature of the substance. The explanation of this phenomenon as developed by the late Lord Rayleigh, Born, Sir J. J. Thomson and others is that the molecules which scatter the light are optically anisotropic, that is, have different refractivities in different directions, and are oriented arbitrarily in space. From the point of view of dispersion-theory, the interpretation usually given is that the electrons responsible for the refraction of light are anisotropically bound in the molecule.

This way of regarding the matter, though perhaps not formally incorrect, does not hold out much hope of progress in interpreting the experimental results, owing to the scantiness of our knowledge regarding the manner in which the dispersion-electrons are bound in complex molecules. Recently, under the writer's direction, a series of accurate measurements have been made in his laboratory of the scattering of light in some thirty different gases and vapours by Mr. A. S. Ganesan, and in more than sixty different transparent liquids (chiefly organic compounds) by Mr. S. Krishnan, and the empirical knowledge thus accumulated of the relation between light-scattering and chemical constitution emphasised the unsatisfactoriness of the position of the subject on the theoretical side. Thus,

for example, the observations showed that molecules containing elongated chains of CH_2 groups and therefore highly unsymmetrical in shape are, optically, much more nearly *isotropic* than benzene, toluene and other compounds of the aromatic series.

These and other results stand in need of explanation, and it is the purpose of this note briefly to indicate a method of dealing with the matter which is at least a useful working hypothesis. The suggestion is that the optical anisotropy of the molecule is due, in the main, to the mutual influence of the electric doublets induced by the external field in its constituent atoms, the latter, individually, being themselves more or less completely isotropic. A similar idea has recently been used very successfully by W. L. Bragg to explain the doubly-refractive character of substances in the solid crystalline state, *e.g.* calcite and aragonite.

Following up the working hypothesis indicated, Dr. K. R. Ramanathan has, at the suggestion of the writer, calculated the degree of optical anisotropy to be expected theoretically for the molecules of a number of substances in the gaseous state and obtained most encouraging results. The fullest test of the theory will be that furnished by the series of organic vapours studied; the detailed calculations necessary for this purpose have been undertaken. Qualitatively, it is not difficult to see that the closer packing of the atoms in the benzene rings compared with that in the chain compounds would enhance their mutual influence, and that, consequently, the greater anisotropy exhibited by the compounds of the aromatic series is what we should expect on the hypothesis suggested. C. V. RAMAN.

s.s. *Kaisar-i-Hind*, near Marseilles,
June 19.

Emission of Volcanic Gases.

I TOO have been shown the effect described by Prof. Conway in NATURE of June 21, p. 891, at the Solfatara, near Naples. I was inclined to believe in its objective reality, but was not sure. I write to suggest that some scientific man who is taking his holiday in that neighbourhood should carry a camera with him, and obtain a photograph before, and another after, the torch has been applied to the vent. In that way I think it would be easy to decide objectively whether the distant vents are affected or not. RAYLEIGH.

69 Cadogan Square, S.W.1, June 21.

I WAS glad to see Prof. Conway's letter on the "Emission of Volcanic Gases" in NATURE of June 21, in which he directs attention to the remarkable phenomenon observed at the volcano of Solfatara when a lighted torch is waved over one of the vent-holes in the crater.

I was also present at Naples on the occasion mentioned, and, along with some friends, took the opportunity of visiting Solfatara, where we observed the phenomenon described by Prof. Conway.

The increase in the amount of fumes emitted was quite unmistakable. A. A. ROBB.

Cambridge, June 22.

I HAVE seen repeatedly during the last thirty-eight years the evocation of gas at Solfatara, described by Prof. Conway in NATURE of June 21, p. 891. The phenomenon is certainly not subjective, neither is it trickery. I venture to offer the hypothesis that, under the floor of the crater, deep caverns are filled with volcanic gases, the equilibrium of which is unstable to a small change in atmospheric pressure, such a change being effected when the air above a group of crevices is heated by the torch. The crevices must be connected with the deep reservoir by passages, and the gas must be generated into the reservoir at a pressure exceeding atmospheric pressure by the pressure due to the vertical column of heavy gas in the passages, added to the pressure necessary to produce the flow of the gas through their length.

Instability is due to the fact that gas drawn up to the torch is hot gas, which therefore rarefies the air more, and so draws up more and hotter gas; and further, that the torch drawing gas from the passages to the crevice must draw also gas from the deep reservoir to the passages and from the lower part of the passages to their upper part. In all cases the gas passes from deeper and therefore hotter strata to higher and therefore cooler strata—so that the whole gaseous column becomes warmer and therefore lighter than it was before. Consequently the weight of the column no longer equipoises the pressure in the deep reservoir, and this therefore forces out gas by the passages through every aperture, the uprush further heating and lightening the column, and therefore renewing itself, until a second equilibrium is reached at a lower reservoir pressure plus a more rapid upward flow of gas. Eventual slackening of this flow and reversal of the steps must be brought about by the cooling of the deep chambers producing a lower pressure of generation; this reduces the rate of flow and therefore increases the time which is passed by the column in the cooler strata. The column therefore becomes cooler and heavier and requires higher pressure in the reservoir to lift it, while the escaping gas is cooler and the rarefaction of the external air lessens. Each consequence reinforces its cause, until the *status quo ante* is reached with the external atmosphere at its original temperature and pressure.

Evidence for the existence of large unstable gaseous reservoirs has lately appeared to me to concern not only the colliery engineer, but also the biologist. It seems possible that some of H. Munro Fox's interesting lunar cycles in life-histories, especially of marine organisms,[1] might conceivably be explained by the earth-wave of spring-tides distorting the walls of subterranean caverns filled with gas, and so releasing an importantly greater quantity of carbon dioxide, etc., at the new and full moon. Thus the constitution of the sea-water in their neighbourhood would have a fortnightly and monthly chemical periodicity which would produce a physiological periodicity in inhabitants sensitive to those constituents.

GEO. P. BIDDER.

Cambridge, June 22.

PROF. CONWAY'S letter in NATURE of June 21 again directs attention to this remarkable phenomenon. Since my former visit, my daughter, Ruth Place, has visited the volcano for further investigation, and we suggest that the sudden emanation of visible gases and vapours may be the effect of ionisation started by the torch flame.

There may be another explanation. The whole system must be charged with superheated aqueous vapour, the temperature varying from 99° C. to 161° C., as observed by Prof. Mercalli, the lower temperature obviously that taken near the surface. When the organic substance, namely, resin torch, or even a bunch of brushwood, paper, etc., is burnt, it will produce water which will condense the hot aqueous vapour and form fog, and so will quickly influence the whole zone and become visible over an extensive range of ground. JOHN PLACE.

16 The Avenue, Beckenham, Kent.
June 30.

[1] At Naples *Nereis dumerilii* and *Dictyota dichotoma*, both breeding fortnightly (Proc. Roy. Soc., vol. 95, p. 544).—Note that there are effervescent hot springs known to bathers in the sea at Bagnoli, near the Solfatara.

Explanation of Abnormal Low Voltage Arcs.

IT is well established that arcs in gases or vapours may be maintained at voltages as low as their ionising potentials, or, in cases where cumulative ionisation is possible, as low as their radiating potentials, provided a hot cathode is used as a source of electrons to stimulate the arc. Considerable discussion has arisen over certain cases in which arcs have been maintained at still lower voltages,[1] since at such voltages the electrons are known not to effect partial or complete ionisation of molecules with which they collide.

Recently Bar, v. Laue and Meyer [2] and, independently, the present writers,[3] have shown that this may be accounted for by the existence of oscillations the peak voltage of which always exceeds the lowest radiating potential of the gas. An experimental and theoretical study of these oscillations has shown them to be in the nature of current interruptions occasioned by the rise in current and consequent drop in voltage occurring when the ionisation is sufficient to create a positive space charge around the filament. Under such conditions there is nothing to prevent a rise in current to its saturation value. With such a rise, the increased potential drop in the series resistance reduces the voltage across the arc. If this reduction takes the voltage to a value below the lowest critical potential of the gas, the current can be maintained only so long as the supply of previously excited atoms persists, after which the current decreases, the voltage rises, and the cycle is repeated. Reactance in the circuit is not, as believed by Bar, v. Laue and Meyer, essential to the oscillations, though it does affect the wave form.

The above phenomenon does not explain all cases of abnormal low voltage arcs, however, for we have maintained arcs in helium, mercury vapour and argon, without oscillations, at voltages well below the lowest critical voltages of the gases. Also Holst and Osterhuis [4] have reported steady arcs in argon at 3·5 volts and neon at 7·5 volts, whereas the lowest critical potentials of these gases are 11·5 and 16·7 volts respectively. To account for this, these authors have proposed a rather elaborate theory of progressive ionisation. The following experiments, however, explain entirely these abnormally low voltages simply on the basis of well-known phenomena.

A short hot-filament cathode and a sheet nickel anode were placed about 1 cm. apart, and a 3 mm. length of 1 mil wire projecting from a glass stem was introduced as an exploring electrode in a bulb filled with pure argon at 2 mm. pressure. This electrode was used according to Langmuir's recent method,[5] and was movable to different points in the discharge by a flexible copper-to-glass seal.

It was found that the arc could easily be maintained at an applied voltage of about 4 volts, without oscillations. Under these conditions, however, *the gas near the filament was found to be at a potential of about 11·5 volts above that of the filament*, and there was an electric field in the direction reverse to the applied field throughout most of the space between the electrodes. Furthermore, the concentration of ions, either positive or negative, was found to decrease from about 100×10^{10} per cc. near the cathode to about 2×10^{10} per cc. near the anode. The average kinetic energy of the electrons outside the region of the cathode drop was found to vary from 2 to 4, in equivalent volts. Analogous results were found in a mercury arc, operating at about 3·5 volts.

Evidently there is *always* a sufficient cathode drop to produce ionisation. If the ionisation is intense, positive as well as negative ions move toward the anode, and at approximately equal rates. To cause this, the reverse electric field, caused by difference in rates of diffusion of electrons and positive ions, takes such a value as to cause the two types of ions to move toward the anode at nearly equal rates. It is easily shown that the number of ions of either sign is at least a million times greater than the excess of one kind over the other, except in the region of the cathode drop.

A fuller treatment of this problem and its significance in the Geissler tube discharge will soon be published.

We are indebted to Dr. Irving Langmuir for suggesting this general line of explanation of the abnormal arc.

KARL T. COMPTON.
CARL H. ECKART.

Princeton University.

[1] Compton, Lilly and Olmstead, *Phys. Rev.*, 4, p. 282, 1920; A. C. Davies, Proc. Roy. Soc., A, 100, p. 599, 1922.
[2] *Zeits. f. Phys.* 20, p. 83, 1923.
[3] *Science*, 59, p. 166, 1923.
[4] *Physica*, 4, p. 42, 1924.
[5] *Gen. Elec. Rev.*, p. 731, Nov. 1923.

De Broglie's Theory of the Quantum and the Doppler Principle.

L. DE BROGLIE (*Phil. Mag.*, Feb. 1924) has recently suggested a theory of the quantum in which the quantum is supposed to be a corpuscle of exceedingly small rest mass M which moves with a velocity βc, where β is less than unity by an exceedingly small amount. The momentum of such a corpuscle is $M\beta c/\sqrt{1-\beta^2}$, and is equal to that of the light quantum $h\nu/c$. Since β is so nearly unity, the momentum may be written as $Mc/\sqrt{1-\beta^2}$. Different values of the frequency ν are explained as being due to different values of β.

Let us suppose that an atom is moving towards the observer with a velocity $\beta_1 c$, and that while moving with this velocity the atom ejects a quantum in the direction of the observer, the frequency of the quantum being ν_0 and its velocity $\beta_0 c$ relative to an observer on the atom. The momentum of the quantum relative to the atom is then $h\nu_0/c = Mc/\sqrt{1-\beta_0^2}$. By applying the relativity theorem of the addition of velocities, we have that, if βc is the velocity of the quantum corpuscle relative to the stationary observer,

$$\beta c = (\beta_0 + \beta_1)c/(1 + \beta_0\beta_1).$$

Hence
$$1 - \beta^2 = \frac{(1-\beta_0^2)(1-\beta_1^2)}{(1+\beta_0\beta_1)^2}.$$

Remembering that β_0 very nearly equals unity, and assuming that β_1 is small, we have

$$1 - \beta^2 = (1-\beta_0^2)(1-\beta_1)^2.$$

Hence if ν is the frequency relative to the stationary observer we have

$$h\nu/c = Mc/\sqrt{1-\beta^2} = Mc/(1-\beta_1)\sqrt{1-\beta_0^2} = h\nu_0/c(1-\beta_1).$$

If now we put $\beta_1 = v/c$, where v is the velocity of the atom relative to the stationary observer, we have

$$\nu = \nu_0 c/(c-v),$$

which is the equation expressing the Doppler principle when the velocity v of the radiating atom is small compared with c.

G. E. M. JAUNCEY.
Washington University,
St. Louis, Mo., May 23.

THE result obtained by Mr. Jauncey seems to be quite correct, and I already knew that it was possible to explain all the forms of Doppler effect by means of my "light quantum" conception.

By studying the collision of a moving electron with a light quantum, I have also obtained a formula for the change of frequency which involves both the Doppler effect and the Compton effect.

In a recent number of the *Phil. Mag.* (May 1924) Mr. William Anderson has stated a curious and perhaps not very probable consequence of my views.

I think that the *isolated* quantum of radiant energy can only be considered in radiations of very high frequency (when Wien's law is valuable), but that for radiations of mean or low frequencies we must conceive a sort of aggregation of light quanta. This idea suggested by the form of Planck's law would perhaps allow us to imagine a transition between light quanta and electromagnetic theory and to avoid Mr. Anderson's conclusion.

June 14. LOUIS DE BROGLIE.

Cell Inclusions in the Gametogenesis of Scorpions.

SINCE last winter I have been engaged on the study of cell-inclusions in the gametogenesis of scorpions, and it was, therefore, with some interest that I read the note of Profs. D. R. Bhattacharya and J. B. Gatenby on the spermatogenesis of an Indian scorpion (Palamnæus) published in NATURE, June 14.

I have studied mitochondria in the spermatogenesis of *Palamnæus fulvipes madraspatensis*, and can confirm the following statements of the writers :

(1) " The mitochondria are sorted out whole during the maturation stages." This is true of both the meiotic divisions.

(2) " The number of mitochondria varies in the spermatid."

In *Palamnæus fulvipes madraspatensis* the number varies from four to thirteen.

I am, however, unable to support the statement that " the mitochondria form the sperm tail directly. . . ." During a certain stage in spermateleosis the mitochondria are grouped together at the base of the elongated nucleus. To a large extent they lose their individuality and form a curious oval body—the mitosome—which stains characteristically with crystal violet, Altman's acid fuchsin and iron hæmatoxylin. I have not been able to detect the mitochondria after this stage. Nor have I seen them at any stage descending down the axial filament.

I may here add a note on the mitochondria of the oocyte of the same species. They are remarkably different in their reaction to osmic acid from those of the male germ cells. There is no case on record where the mitochondria are blackened by chrome-osmium alone. Where they are blackened, it is only after prolonged osmication (Kopsch). But the mitochondria in the oocyte are intensely blackened by chrome-osmium alone in ten hours. They are even preserved and blackened by Fleming-with-acetic acid. They can be decolorised by turpentine, but subsequent staining is impossible. They are completely destroyed by Bouin's fluid. These facts undoubtedly suggest the presence of a large amount of unsaturated fat in the mitochondria.

The Golgi apparatus in the oocyte of the same species consists of rods and crescents distributed in patches.

I hope to publish in due course a paper on the cell inclusions in the gametogenesis of Palamnæus (Madras), *Buthus judaicus* and *Heterometrus maurus* (Palestine), and *Euscorpius napoli* (Naples).

VISHWA NATH.

Zoological Laboratory, Cambridge,
June 20.

Art-Forms in Nature.

PERMIT me to thank Mr. Edward Heron-Allen for the very generous reference to my work published in his review of Haeckel's " Kunstformen der Natur " (NATURE, June 14, p. 847). Mr. Heron-Allen says: " A law only approximates to the facts, and every time we use it we have to make appropriate additions and corrections ; the real value of deviations is not that they make it necessary to discard a theory, but that they enlarge our laws and thereby advance our knowledge." This sentence formed part of an appreciation of my book, " The Curves of Life," which was published in 1914. With your permission I will quote a short passage from this book which gives an excellent example of the process mentioned, an example which in 1924 we can all read with a startling verification in our minds.

" The principle enunciated by Newton," I wrote on pp. 429 and 430, " may ' simplify ' the phenomena of our solar system sufficiently to enable us to talk about the movements of the earth and the celestial bodies. But that simplicity, we may feel sure, is only apparent. Newton himself, as far as I am aware, never ventured to suggest any ' cause ' for his great principle. We may well consider that its value as a working hypothesis outweighs the possibilities of its inexactness. But we must be equally prepared to realise that it may not fit all the facts which future science may discover. It is, in H. Poincaré's admirable phrase, *une règle d'action qui réussit* ; or, in other words, we have added (1914) so few phenomena of real importance to those known by Newton that the basis furnished by his ' law ' has not yet been disintegrated. But it is easily conceivable that a broader foundation will be needed, even in the present century ; and we need have no fear that men of science will shrink from the endeavour to provide it. The sterile reprobation of Auguste Comte (who was obsessed by sociological ideas of ' Order ') has long ago become inoperative."

These lines were written ten years ago, and I freely admit that logic had more to do than special knowledge with a prophecy which Einstein was so soon and so brilliantly to fulfil. THEODORE A. COOK.

Savile Club, 107 Piccadilly, W.
June 19.

The Oogenesis of Lithobius.

THE oogenesis of the Arthropoda is the least well understood, because it has presented considerable technical difficulties. In this country Hogben has investigated successfully the oogenesis of dragonflies, and has shown that the nucleolus takes important direct part in the production of the yolk spheres.

The oogenesis of Lithobius appears to be much like that of Hogben's examples, and is probably general for Arthropoda. Yolk formation is from nucleolar extrusion, of which two phases can be distinguished ; first, an early extrusion of particles budded off from the large central nucleolus, which retains its individuality, and, secondly, an extrusion of particles derived from the fragmentation of this nucleolus. These particles multiply both in the nucleus and in the cytoplasm. The fate of the first nucleolar extrusions has not been determined, but the later extrusions enlarge after proliferation to form the definitive yolk spheres. The Golgi apparatus behaves in the usual way, being excentric and juxta-nuclear in the youngest oocytes, then spreading out through the cell, and breaking eventually into very fine grains. The mitochondria are diffuse in the earliest stages, then become concentrated to a cloud near the nucleus ; this breaks up into a number of clusters, some of which become active centres of proliferation. These form curious round mitochondrial bodies, which later fragment, the mitochondria passing out to become evenly distributed through the cytoplasm. The clouds which did not take part in the rapid proliferation also become scattered at the same time.

A full account of the oogenesis will be published later. S. D. KING.

Zoological Department,
Trinity College, Dublin.

Artificial Daylight.

By Dr. L. C. MARTIN.

THE apparently simple question "What is Daylight?" raises at once a host of supplementary questions which are not easy to answer, and a little consideration shows that "daylight" is a word of somewhat indefinite meaning. The paper on which the present article is being written is illuminated by light from a north window. The sky is blue, but flecked with white clouds reflecting winter sunlight. A proportion of the light is, however, coming from the walls of an opposite house, and since this house is flanked by green trees and shrubs, they are also contributing their share of reflected light. A spectrophotometric examination of the light would doubtless reveal a somewhat irregular spectral distribution of energy, varying from minute to minute, although the eye registers no marked change in the appearance of the paper. Even after the drastic step of drawing the blinds and switching on the electric light, the appearance will scarcely indicate the tremendous alteration in the nature of the light, at any rate when the eye has been accustomed to the changed conditions. It is not until some effect of simultaneous contrast brings the artificial light into comparison with daylight that the difference between the two is revealed.

It is quite clear that it is useless to attempt to copy the heterogeneous radiation described above; therefore it is necessary to study the distribution of energy in the spectrum for summer sunlight and the light from a blue sky, and to see how far the means at present available will allow the production of radiation with similar characteristics. Some suitable compromise can then be decided upon. Fig. 1 shows, reduced to a common ordinate at 0·59μ, the *relative* distribution of energy in the spectrum for blue-sky light, summer sunlight, and electric light (gas-filled incandescent lamp). The gas-filled lamp radiates, as indicated by experiment, in a manner similar to a perfect radiator (the black body of the physicist) at a temperature of 2800° C. By extrapolating from experimental results, it is found that the sun radiates like a perfect radiator at about 5000° C., a temperature unfortunately quite unattainable at present in any usual and practical terrestrial source of light. It is only in intense electric discharges that such temperatures can be attained experimentally.

Amongst the special means of light production the Moore vacuum tube must be mentioned. The discharge from a small transformer passes through rarefied carbon dioxide at a pressure of about 0·1 mm., the tubes being of considerable length when used for industrial lighting. Luckiesh states that the light is a "good approximation to average daylight." Since the spectrum consists of bands, however, and is by no means continuous, this light is apt to prove untrustworthy for colour matching purposes, more especially in dealing with substances possessing bright narrow bands in the spectrum of their transmitted or reflected light.

Phosphorescence and allied effects are extremely efficient in regard to the energy required in producing a given amount of light, but under present conditions the utilisation of the phenomena for commercial light production is not practicable.

We turn, then, to consider the means of modifying the energy distribution in the spectra of ordinary sources, and before proceeding to the better known methods, two useful laboratory devices may be mentioned. Priest finds that by passing the light through a system of polarising prisms and quartz plates cut perpendicular to the axis, the spectrum of such a source as the gas-filled tungsten lamp can be modified to an equivalent of that from a black body radiating at 5000° C., and moreover, the apparent temperature of the equivalent radiator can be controlled over a wide range. The Arons chromoscope is convenient for the purpose. Another method of interest is the spectrum template of Abney and Ives, in which the radiation from the source is first dispersed

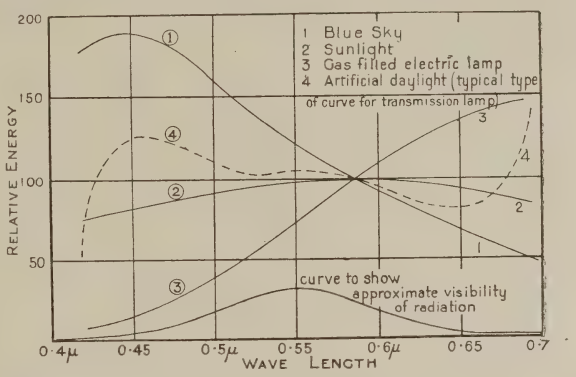

FIG. 1.—Relative distribution of energy in spectra of light sources.

into a spectrum and then recombined. In the plane of the spectrum a sector rotates, and one of the lines bounding the angular opening of the sector is curved in such a way that the effective angular aperture varies so as to be greatest in the blue and least in the red regions of the spectrum. In fact the apparent energy distribution in the spectrum of the reconstituted light can be made to follow any prescribed law.

It will be apparent, however, that the two foregoing methods are wasteful in so far as their action depends on the mere elimination of the excess energy of the longer wave-lengths.

Apart from consideration of energy distribution, however, the two methods above are quite impossible for lighting purposes, and therefore the aid of selectively transmitting or reflecting light filters or reflectors has to be employed, this expedient being suggested by Mr. A. P. Trotter some thirty years ago or so. In 1899 Dufton and Gardner produced a filter for correcting the light from the carbon arc. Though this light has an energy distribution which comes almost as near to sunlight as any artificial light (the temperature of the carbon arc is 3500° C. to 4000° C.), the flame of the arc gives an excess of violet radiation from the well-known cyanogen bands, and hence the radiation needs a special type of correction. Dufton and Gardner's glass was coloured blue-green by means of copper, and a trace of uranium gave the property of filtering out the excess of violet from the arc-light.

Since that time several types of colour filter made of

special glass, or glass in series with dyed gelatin films, have been introduced for the correction of the light from other artificial sources, namely, ordinary metal filament electric lamps, gas-filled electric lamps, and incandescent gas lamps. Lamps employing coloured reflectors have also been introduced. The gas-filled electric lamps work at a higher temperature than those of the ordinary metal filament type, and consequently the correction required to produce artificial sunlight is less drastic in the first case. The correction for an incandescent gas mantle is even less since the spectrum of the radiation is particularly rich in the shorter wavelengths as compared with the radiation from a "black body" at the same temperature.

On the whole, experience has shown that the gas-filled lamp lends itself most readily to the present purpose, and practically all the modern lamps start with this light mainly because gas-filled lamps can be readily fitted into a lantern or shade without the greater difficulties of ventilation encountered when using an arc or gas burner.

There are at present several varieties of artificial daylight lamps on the market. In the first type the lamp is enclosed in a lantern with a reflector, and the light passes through a colour filter, the glass being coloured by various proportions of cobalt, manganese, nickel, and copper. Suitable glasses have been produced by Ives and Brady, and by Gaze in America. Messrs. Chance Brothers of Birmingham have also produced a "Daylight" glass. The type of correction usually aimed at is a compromise between the energy distribution found in sunlight and blue-sky light; thus the luminous efficiency of such units considered merely as sources of light is inevitably low. In one transmission lamp recently examined by the writer the overall efficiency was only 8 per cent. as compared with the unshaded lamp, but this was employing an ordinary metal filament bulb. If a gas-filled bulb had been employed the efficiency would probably have been much greater, perhaps 12-15 per cent.; a great deal depends on the reflector, which can, if well designed, produce a considerable concentration of light, thereby counteracting the unavoidable disadvantage of the loss of light in the filter.

The glasses employed for the filters often show some deviation from the desirable smooth transmission curve. In the unit due to Lamplough a small excess of green transmitted by one blue filter is compensated by the provision of a second filter of glass slightly coloured purple by the use of gold. The purple filter absorbs the excess of green and the quality of the light is greatly improved.

A second type of lamp (the Sheringham Daylight) employs the device of reflecting the light from a surface coloured with patches of blue, green, and red or yellow pigments in definite proportions of area. The light is completely diffused, and this is a considerable advantage when imitating the effects of actual daylight. Furthermore, the energy distribution of the reflected light can be made very "smooth," although it is difficult, just as before, to secure drastic correction without undue loss of energy. The method of making a spectro-photometric comparison between natural and artificial daylight has been described by Mr. P. R. Ord in the *Illuminating Engineer* for July 1923, but there is at present very little available information on the relative performances in energy distribution and luminous efficiency of the various lamps.

The actual correction attained in all these lamps is good over the brightest part of the visible spectrum between 0·45μ and 0·65μ. At the violet end the radiation is very deficient in violet, and at the extreme red end practically all the commercial units give far too much energy (see Fig. 1). The fact that these defects do not destroy the ordinary usefulness of the lamps is owing solely to the low visibility of the radiations corresponding to extreme ends of the spectrum, as shown by the lowest curve in Fig. 1. Occasionally the error is made manifest by some material with a low reflection through most of the spectrum and a large reflection at the red end. The "artificial daylight" may then produce a different appearance in such a substance as compared with daylight itself, but on the other hand, such materials vary greatly in appearance under the variations of daylight.

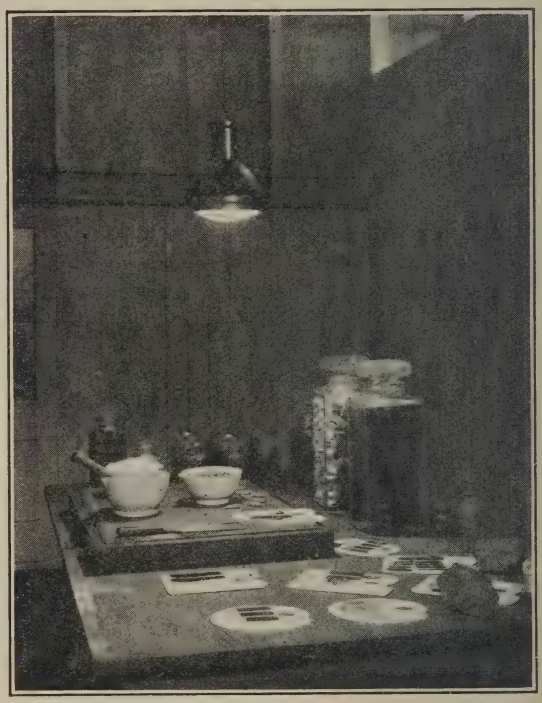

FIG. 2.—Lamplough daylamp (200-watt industrial model) in use at the laboratories of Messrs. Winsor and Newton, Ltd., for grading pigments. By courtesy of The Lamplough Daylamp, Ltd.

A third type of lamp usually employs a simple coloured bulb, either of coloured glass or coated with a gelatin filter. The correction in many of these units is not nearly so thorough, and therefore the luminous efficiency can be kept much higher, perhaps up to 60 per cent. or so. While lamps of this kind give a much better sense of relative value to blues and greens, they are of little use when exact colour matching is of importance, and recourse must therefore be made to the more fully corrected units.

Other types of lamp, of Continental origin, employ two or more colour filters. The light transmitted through these filters is mixed by diffusion.

In considering the spheres of usefulness of such lamps as are at present available, we recall first of all the considerable number of industries in which "grading" and estimations of quality of products by visual appearance are of the greatest importance. Tea, leather, tobacco, seeds, flour, and many other materials are all judged by colour, and until the modern daylight lamps were available a very great deal of time was lost owing to the lack of good daylight often experienced during the winter in industrial towns. So far as can be judged, however, artificial daylight has proved entirely satisfactory for purposes of this kind when sufficient care is employed in choosing a lamp suitable for the work in hand. A jeweller requires a strong light concentrated in a small area, and for this work one of the lamps with a focussing reflector would be best. On the other hand, for warehouse lighting a lamp giving good diffusion, such as the Sheringham Daylight, may prove the more suitable. The fully corrected lamps have been adapted for studio lighting by artists, and for counter illumination in drapers' shops and elsewhere. Fig. 2 shows a "Lamplough" transmission unit in use for grading pigments at Messrs. Winsor and Newton's.

Persons with experience of work with the artificial daylight units learn to adapt their estimations to the relatively constant light of these lamps, and less difficulty is often experienced than in working with highly variable daylight.

The "higher efficiency," and less fully corrected, lamps are applied with success for the lighting of shop windows by drapers and florists. A great improvement in colour values is secured without undue expense. The main factor militating against the employment of artificial daylight for general lighting seems to be a purely psychological one. Objection is taken to the "cold" appearance of the light when contrasted with that from ordinary lamps, but after all the matter is scarcely of importance if the corrected light is readily available when required.

It may be recalled that the difficulty of obtaining a reasonably constant standard of white light is one of the greatest difficulties in the application of colorimetry for modern industrial purposes. Stanford (*Biochemical Journal*, xvii. No. 6, 1923) has recently pointed out the usefulness of an artificial daylight lamp (the Sheringham lamp was actually used) for purposes of colorimetry with limited range colorimeters,[1] and for many chemical estimations, such as comparisons in Nessler cylinders. Artificial light corrected thus, or by a suitable filter of daylight glass, or by one of the laboratory methods described above, is of the greatest service in the more general problem of colour measurement which is being investigated with much energy in Germany and America at the present time, although the subject seems to attract little attention in Great Britain.

In conclusion, one might comment perhaps on the lack of interest shown by commercial firms in the subject of artificial daylight, and the improvement of lighting generally. In 1920 there were 15,000 fully corrected artificial daylight lamps in use in America, and the demand was then rapidly growing. In Great Britain it is doubtful whether a tenth of the American demand has been reached. The saving of time effected by the employment of such lamps in bad weather is so great that this indifference seems extraordinary, and the sooner this state of affairs is remedied the better for those industries to which this subject is of importance.

[1] See "Colour and Methods of Colour Reproduction" (Blackie), p. 114.

The Plant Commonwealth and its Mode of Government.[1]

By Sir FREDERICK KEEBLE, C.B.E., F.R.S.

TO describe in any detail the different kinds of receptor, or receiving apparatus, whereby an external stimulus of light, gravity, etc., is registered by the plant, lies beyond the purpose of this discourse. It is, however, essential to that purpose to point out that the region of reception of the stimulus is often separated by some distance from the region of reaction. Cut or burn the root of a sensitive plant, and presently the leaves begin to move. First, those nearest to the base of the stem bend down hingewise on the leaf cushion (pulvinus) and their leaflets fold together; then in succession those higher up the stem undergo a like series of changes, until all have soon reacted to the shock. Place a root on its side and its growing region an inch or so behind the tip, elongating more on the upper than on the lower side, initiates a curvature which continues until the tip points again vertically downward. But if, as Darwin showed, the tip be cut off before the root is placed in a horizontal position, no curvature occurs until a new root-tip has been regenerated. In the intervening days the root continues to grow horizontally. Cover or cut off the tip of the first leaf of a grass seedling and the actively elongating region fails to respond by curvature to one-sided illumination.

It is therefore evident that there is often a definite separation of receptor and effector region, and one of the most interesting problems in plant physiology is to discover how that gap is bridged. In animals nerves serve to connect the receptor organs—the receivers of specific stimuli—and the effector organs—the structures which respond by movement or other definite changes. But though many have sought for and some have thought to find them, those specialised conductors of excitation which are called nerves appear to be absent altogether from plants. Some have believed that the intercellular protoplasmic fibres serve like nerves to conduct impulses. It may be so, but facts are not very favourable to this interpretation of their function. It would, indeed, seem more probable that the protoplasmic intercellular strands serve to transmit not nervous impulses but materials from cell to cell.

There is, however, no need to carry these speculations further, since recent discoveries have thrown a new light and put a different complexion on the mode of transmission of excitation in plants. If a little mica plate be inserted into a cut made half way across the

[1] Continued from p. 15.

tissue of the first leaf of an oat seedling at a short distance behind the receptive tip, excitation resulting from unilateral illumination is transmitted as in intact plants. But if a second plate of mica be inserted in a second cut made on the opposite side at a slight distance from the first no curvature results; the plant remains unresponsive to unilateral illumination. Similarly, as might be supposed, if the tip be cut off completely and replaced so that it rests on a plate of mica introduced between it and the rest of the leaf, curvature does not occur. But if the tip be cut off and glued on again with gelatin, unilateral illumination induces the same curvature as it does in the intact oat leaf. The receptor apparatus in the tip suffers no damage from the operation, and undergoes the same excitation as in the normal plant. This excitation passes through the gelatin to the intact effector region and brings about in that region redistribution and changes in rate of growth which are made manifest by curvature.

There would, therefore, appear to be no escape from the conclusion that that which passes from receptor to effector regions is a stimulatory substance—a hormone. The message transmitted by the receptive tip to the reacting region is a chemical message. As a letter in the post-bag may pass many doors and cause no stir until it is delivered at the right address, so the hormone which evokes heliotropic response passes through or by many cells without, so far as is known, producing any effect upon them. It is not for their address. Only when it reaches the cells beyond the growing point which have ceased to divide and begun to grow in length and breadth does the message which the hormone bears become significant. Similar beheading and reheading experiments have been made by Mr. G. R. S. Snow in my laboratory. Although it might seem unduly sanguine to expect anything to happen after a root tip has been cut off and stuck on again, the experiment, which has now been repeated many times, demonstrates that the receptive tip, after the operation, responds to the stimulus of gravity stimulation, and that the message which provokes curvature in the growing region is transmitted across a gelatin junction. For if after replacement of the cut off tip the root is laid in a horizontal position, instead of remaining in that position as a tipless root does, it curves until the tip points once again vertically downward.

No less remarkable are the discoveries which have recently been made by the Italian physiologist, Ricca, on the much investigated subject of the movements of the Sensitive plant, *Mimosa pudica*, and allied sensitive species. The movements of this plant have often been described and always excite wonder. In tropical countries, where the Sensitive plant grows close to the ground and covers large tracts, any one who walks over it may see the leaves bending down and folding up as his foot approaches, as though the plants were shrinking from impending danger.

Many explanations have been offered of the significance of these movements; but none seems satisfactory. Extreme sensitiveness to contact is not peculiar to the species of Mimosa. It is manifested also by other genera of plants, by Neptunia, which, like Mimosa, belongs to the Legume family, and by Biophytum, *e.g. Biophytum sensitivum*, a member of the Geranium family. A recital of all the interesting experiments which have been made on *Mimosa pudica* from the time of Claude Bernard to the present day is beyond my powers or your patience. Nor is the recital necessary for my present purpose, for the new classical experiments of Ricca, and the as yet unpublished experiments made recently by Mr. Snow, throw new light on the nature of the message which passes to the leaves when the plant is stimulated as it may be by tapping, shaking, cutting, or burning a part of it. Working with strong-growing woody species in the congenial climate of Italy, Ricca has shown that the excitation set up by stimulating a part of the stem travels in the wood. Even after all the other tissues of the stem are removed the excitation continues to pass upward and to bring about progressively the characteristic movements of the leaves. If a length of stem above the point to be stimulated is killed, as, for example, by subjecting it to high temperature, the message still passes and is delivered to the living leaves above the killed region of the stem.

That the excitation is of a chemical nature is shown by cutting the stem, interposing a short tube containing water between the severed ends, and then stimulating the lower part of the stem. Even under these untoward conditions the message is delivered. The hormone, rising with the water current up the vessels, diffuses through the column of water in the glass tube and, passing into the vessels above the cut, travels along them; and at each level at which a leaf is borne, the hormone passes into the motile pulvinus and excites its tissues, so that the turgid cells of the under side of the pulvinus lose water and resilience and, becoming flaccid, no longer bear up the leaf stalk, which therefore falls like a flag at half-mast. As in old times, a knocker-up went round the town leaving his noisy message at the appointed doors, so the hormone, albeit more discreetly, travels through the watery highways of the plant delivering its chemical message as it goes.

Research, however, whilst unveiling old mysteries discovers new ones, and Mr. Snow, who has just come back from studying the behaviour of Sensitive plants in the West Indies, informs me that whilst he has confirmed Ricca's remarkable results, and has shown that the hormone which travels through the wood may be made to diffuse across a film of collodion without losing its potency, has also discovered that this is not the whole of the story. Transmission of excitation in the Sensitive plant is apparently of two kinds. There is the relatively slow transmission of a specific hormone by way of the wood vessels of the stem; but there is also a high-speed transmission, far more rapid and much less far-reaching. When this high-speed transmission of excitation is employed by the stem, the track which it follows is not that of the wood vessels, nor does it lead to movement of more than two leaves above the point of stimulation.

Mr. Snow has demonstrated the existence of these two modes of transmission by the simple device of making very gradually an oblique cut in the stem. As the knife penetrates into the deeper tissues below the cortex—which tissues are known as the phloem or bast—a drop of fluid exudes from the cut. It used to be supposed that this exudation, which escapes from

certain long tubular cells, is the sign of some hydrostatic disturbance in these cells, and that this disturbance leads to the setting up of a pressure wave which evokes the movement of the leaves. But if the knife be stayed at this point, though the water drop gushes out, nothing else happens. Let it, however, be pressed a little so that it penetrates deeper into the bast and reaches to, or almost to, the cambium, which lies between bast and wood, and suddenly the high-speed transmission takes place; in a flash, the nearest two leaves fall. If the knife be withdrawn no further excitation takes place, but if it be pushed home into the wood, the second more leisurely mode of transmission comes into play. The chemical messenger which travels into the water current in the wood vessels is released and, slowly but surely, as the transpiration current rises through the stem, leaf after leaf falls until all have shown by their position that they have received and responded to the message.

These observations come opportunely. Without them I should have been tempted to round off my discourse with a confident generalisation. The varied happenings in the plant commonwealth which I have described—the revival of powers of cell-division in wounded tissues, the heliotropic curvatures of roots and stems, the ordinary response of the Sensitive plant to shock—all are brought about by specific chemical messengers or hormones. Many other phenomena of plant response to stimulation are undoubtedly also due to hormones. May it not therefore be that the mode of government of the plant commonwealth is not duplex, like that of animals, but simplex? Whereas the integration of the animal body into an individual is the outcome of messages of two kinds, the integration of the plant body is effected by messages of one kind only. In the animal body, the two kinds are those messages transmitted at high speed along the nerves and those material messages or hormones, which are distributed by means of the blood stream. In the plant body, messages of the latter kind only are at present and with certainty known to pass to and fro between the members of the commonwealth.

Until, however, the nature of the high-speed transmission of excitation in Mimosa is explored, it would be rash to predict confidently that the fundamental difference between plant and animal will be found to lie in this, that the plant commonwealth has not and never had the means of rapid message-sending which in the animal world takes place by means of the nervous system, and that the passionless perfection of plants has been achieved solely by developing the system of special messengers. Or adopting Bayliss's metaphor: If the integration of the animal is to be regarded as due to the simultaneous employment of a telegraph system and a postal service—one for quick messages which may be of a physical kind, the other for less rapid messages of a material kind—then it may be that the integration of the plant commonwealth has been and is effected solely by the employment of the postal system. One—the animal world—partakes rather of the nature of an empire, and the other—the plant world—partakes of the nature of a commonwealth, and if so the title of my discourse needs no further justification.

Obituary.

PROF. J. G. LONGBOTTOM.

THE death has been announced, at the early age of fifty-four, of Prof. John Gordon Longbottom, of the Royal Technical College, Glasgow, which occurred on June 6 after a serious operation. Prof. Longbottom was a native of Keighley, Yorkshire, and served his apprenticeship in engineering in the works of Messrs. F. and J. Butterfield. His technical education was received at the Bradford Technical College, and a Whitworth Scholarship enabled him to proceed to the Royal College of Science and University College, London, where he became an assistant to Prof. Karl Pearson. About twenty-eight years ago he joined the staff of the Ro ya Technical College, Glasgow, and became professor of mechanics on the retirement of the late Prof. Rowden.

Prof. Longbottom was very retiring, and consequently his abilities were not widely known outside the College. His mathematical knowledge and his power of applying it to practical problems were of great advantage to his students, who will remember him not only for the soundness of his work, but also for the kindliness of his disposition. His appointment was made prior to the erection of the new buildings of the College, and he was therefore responsible for the equipment of the Materials Laboratory—an installation which is worthy of the College. He was a member of the Institution of Mechanical Engineers and of the Institution of Engineers and Shipbuilders in Scotland; he contributed to the latter Institution a paper on the stresses on the rim and arms of a flywheel.

PROF. IAN DEYL.

PROF. IAN DEYL, who died on February 4 in Prague, was born in 1855 in Vysoké Veselí nad lidlinon, and prepared himself for the duties of an all-round practical surgeon. But at last he became an ophthalmologist. I cannot dwell here on his numerous original investigations so far as they refer to medicine, of which the most interesting ones treat of the relations of eye diseases to the diseases of the body. He solved in fishes and birds the most complicated problem of the embryology of the mechanism of the eye, namely, the way in which the crossing of the eye-nerves on the lower part of the skull takes place.

Deyl was a member of the Bohemian Academy of Sciences, of the Royal Society of Bohemia, of the Ophthalmological Society, etc. He was of noble character and a great benefactor of the blind, and an institution for the blind bears his name.

BOHUSLAV BRAUNER.

We regret to announce the following deaths:

Dr. C. E. Moyse, emeritus vice-principal of McGill University, Montreal, aged seventy-two.

Sir Jethro Teall, F.R.S., lately Director of the Geological Survey of Great Britain and of the Museum of Practical Geology, London, on July 2, aged seventy-five.

Sir Harry Veitch, formerly vice-president of the Royal Horticultural Society, on July 6, aged eighty-four.

Current Topics and Events.

A CONFERENCE arranged at the British Empire Exhibition by the Royal Society for the Protection of Birds took place on June 26. The subjects for discussion were legislation for bird protection in different parts of the British Empire, the oil menace, and the formation of Nature reserves and bird sanctuaries. Overseas representatives described the conditions in their respective countries. In some of these the question of the preservation of bird life is a very urgent problem: on the one hand the changes within recent years—owing to the rapid increase of human population and all that it implies—are very obvious, while on the other hand the need for counteracting insect pests is particularly great. In some parts of the Empire, legislation on the subject is ahead of that in Great Britain, but although high penalties are imposed, enforcement of the law is often difficult. One is glad to see this subject discussed in its wider aspects, even although foreign countries were on this particular occasion not included. Owing to the seasonal movements of birds from one country to another, international co-operation in protective measures is highly desirable, and we were told at this conference how much the Migratory Birds Treaty with the United States has done for the Canadian summer avifauna. The oil menace also requires international handling, because the waste oil which nowadays causes so much cruel and unnecessary destruction of birds, as well as of fishes and other marine animals and of seaside amenities, is as a rule originally discharged at sea outside territorial limits.

AT the close of the current session, Prof. J. B. Cohen will retire from the chair of organic chemistry in the University of Leeds, severing a connexion which dates back to 1891. In that year, after some experience in the works of the Clayton Aniline Company and in the Chemistry Department at the Owens College, Manchester, he was appointed lecturer in organic chemistry and afterwards became the first occupant of the chair of organic chemistry established in 1904. To the advancement of organic chemistry Prof. Cohen has contributed very substantially in many ways. His original work has centred, for the most part, in problems connected with substitution in aromatic compounds, with the relation between optical activity and position isomerism and with the influence of chemical constitution on the antiseptic properties of organic compounds. His success as a University teacher has been in no small measure due to his faculty for lucid exposition, to his constant attention to the routine laboratory work of his students, and to his never-failing interest in the difficulties of the beginner. To large numbers of organic chemists, his name is particularly familiar as the author of widely read text-books which have played no small part in attracting students to the study of the subject. As a member of Government Committees dealing with the question of smoke abatement, Prof. Cohen has been able to supply valuable data from first-hand observations on the deleterious effects of smoke. Much of his leisure has been given up to social work, and as president of the University Working Men's Club at Leeds, he has, with much success, laboured to bring University students into contact with young working men, to their mutual advantage. In recognition of his services the funds necessary for the establishment of an annual University prize are in course of being provided by Prof. Cohen's colleagues, friends, and past students. To his colleagues, the approaching retirement is an event rendered less regrettable by the knowledge that arrangements will probably be made for him to continue his experimental work in one of the University laboratories.

A MOST interesting appreciation of Lord Kelvin, the centenary of whose birth has just been celebrated, appears from the pen of Sir Oliver Lodge in a recent number of the *Observer*. As a physicist who can enter into the spirit of Kelvin's work in a way that few others can, Sir Oliver sums up the scientific career and genius of the great pioneer with a wonderful sense of proportion. Attention is directed not only to the vast mathematical power and knowledge that he possessed and applied with such notable results to the foundations of thermodynamic and electromagnetic theory, but also to his all-compelling enthusiasm and his remarkable originality and independence of thought. "Many a German professor and some English professors," writes Sir Oliver, "were more learned than Lord Kelvin, but none were so original. . . . His métier was not to follow but to lead." This independence of thought sometimes brought him into avenues from which he was obliged to retreat. The writer pays great tribute to the practical results of Kelvin's labours. His navigational and electrical instruments are household words to-day, and many of his theories have had unexpectedly far-reaching results. He was, however, not always a good judge of his own work. Sometimes he lost his way and floundered. He was an inspiring rather than a safe and secure guide. "But," concludes Sir Oliver, "he has written his name large on the history of physical science, and all the world marvels at his genius and is thankful that he lived."

THE work of William Pengelly as a geologist and as the explorer of Kent's Cavern will always be remembered by scientific workers, and some of his papers must ever figure among the classics of geological literature. The celebration last month of the jubilee of the foundation of the Museum of the Torquay Natural History Society is a reminder of the way in which he has left a mark in the town which will keep his memory ever fresh in the minds of all who know Torquay. In 1844, Pengelly, Dr. Battersby, Mr. E. Vivian and some fifteen kindred spirits founded the Society, but it was not until 1874 that the foundation stone of the Museum was laid by the Rev. T. R. R. Stebbing, president for the year, who is still with us. In March 1894, Pengelly died and a good lecture hall was added to the building as a monument to his memory. For many years the building has been a worthy focus for the scientific thought and work of the Torquay district, a region peculiarly rich in opportunities for

research. Mr. Harford J. Lowe, the honorary secretary, speaking at a garden party held at Torre Abbey, said: "The life of the Society must be credited in a very large measure to the incomparable work, during many years, of Mr. Pengelly, who through his excavations in Kent's Cavern provided the mainstay of the Society and gave it world-wide notability." This note was echoed at a garden party given by Pengelly's daughter, Mrs. H. Forbes Julian, on the following day, and again by an account she gave to the Society of her father's work. "A man," she said, "is best judged by the work he has done, the influence he has exercised during his lifetime, and the results he has left behind for the use of posterity."

TAKING the weather records at Greenwich Observatory as a fair representation of Midland and South-east England, a consideration of the meteorological results for the first six months of the current year shows a prevalence of dull and rainy weather. The mean temperature for the six months is 0°·15 F. above the normal for the past 35 years, and whilst January, May, and June were warmer than the normal, the months of February, March, and April were colder than the normal. In May, the shade temperature was above 70° on 8 days, the highest reading being 79°; the temperature in the sun's rays was 130° or above on 14 days, the highest reading being 150°. In June, the shade temperature was above 70° on 16 days, and on 2 days it was slightly above 80°; the solar radiation temperature was 130° or above on 16 days, and the highest reading was 149°. The rainfall was in excess of the normal in all of the six months except February and March, yielding a total excess of 2·41 in.; the latter half of June was generally dry, rain only falling on 3 days after June 13. Bright sunshine was deficient in all the six months except January and March, the deficiency for the whole period averaging about a quarter of an hour per day; in April the bright sunshine was 1·66 hours per day less than the normal. Although the weather has continued somewhat unsettled there has fortunately been no recurrence of late of the abnormal conditions which continued with such persistence during the winter and early spring.

IN the *Times* of July 2, Mr. Richard O. Marsh publishes an amplified account of the previously reported discovery of "white Indians" in the district of Darien in Panama. The expedition of which Mr. Marsh was leader made friends with the Indians of the district by rendering medical aid in an epidemic of small-pox. They were then induced by an offer of the assistance of the white man against the surrounding "negroid" tribes to end their feud with the "white Indians," who, as the story goes, were either killed or driven to the mountains at the time of the Spanish occupation (1512–1517) owing to the hatred of all white people which had been aroused by the cruelties of the Spaniards. Notwithstanding a ban on their marriage and an order that all their children should be killed, the type has survived ever since. As a result of Mr. Marsh's intervention, the "white Indians" have been re-admitted to full tribal rights. Dr. Breder of the American Museum of Natural History says in a telegraphic despatch that the three "white Indians," whom Mr. Marsh hopes to bring back with him to the United States, have golden hair, blue eyes and white skins, though two have "liver spots," while their skulls are unusual, being round and quite unlike the San Blas Indian type.

To the *Empire Review* for July, Mr. Hugo Hirst contributes a thoughtful paper on the World Power Conference. He points out that power schemes require capital, and this capital can only be obtained by international co-operation. The Conference attacks this problem, and the many papers contributed by authors will be a help in finding a solution. Recent developments in the industrial world will probably determine the course of the economic reconstruction of the world. In the author's opinion, this reconstruction can already be seen to be slowly emerging. Increased international co-operation is wanted in science, in engineering, and in research. Modern industry is based entirely on science, and its continuous development is only possible through research. The great inventions such as those made by Watt and Faraday are essentially simple. To put them into practice, however, requires the expenditure of capital, and only large firms can face this expenditure. To the manufacturer, research is an economic proposition. In Great Britain the question of coal conservation becomes more pressing every year. Our easily worked reserves of coal are diminishing, and so the price of coal is increasing. The cost of fuel is a greater burden on industry than ever it has been before. The many papers read at the Conference showing how other countries are attempting to solve the problem will be of permanent value to every engineer.

AT the World Power Conference at the British Empire Exhibition, papers by Mr. J. W. T. Walsh, Mr. L. Gaster and Mr. C. W. Sully dealing with illumination were read on July 4. As Dr. C. H. Sharp, a delegate from the United States, remarked in opening the discussion, it seems an anomaly that out of the very large number of contributions to this conference only three should deal with lighting. For it is estimated that quite half of the total electrical energy produced is applied in the lighting field. Mr. Walsh's paper was concerned chiefly with the activities of the International Illumination Commission, whilst Mr. Gaster showed how these are linked to other organisations concerned with illumination from the national point of view. Mr. Sully's paper was largely statistical. He showed how the average candlepower of lamps used has progressively increased during recent years, and gave some illustrations of the great opportunities for developments in lighting. There is of course every inducement to companies concerned with the manufacture of lamps or the supply of electricity to encourage the study of illumination. But one is glad to note that this interest is not confined to the purely commercial side. It is essential that the views of experts, especially those concerned with the hygienic aspects of lighting, should be heard and that the subject should be developed on scientific lines.

THE value of the agricultural exhibit (Ministry of Agriculture) in the Government Pavilion at the British Empire Exhibition, Wembley, has been considerably enhanced by the issue of a descriptive guide-book providing a short explanation of most of the exhibits. More than a score of research institutes have co-operated in working out a definite scheme, starting with an exposition of soil problems and conditions, leading through a demonstration of methods of plant and animal improvement to problems of nutrition and pathology, and concluding with the economic aspects under the headings of Horticulture and Farming and Agricultural Economics. The guide-book does not attempt to describe each exhibit individually, but gives a short, general outline pointing out what each case is intended to demonstrate. In some instances, as in connexion with wheat breeding, virus diseases and spraying with insecticides, the principles upon which the research is based are given in some detail, to render the object of the work intelligible to the public. In other cases, as with the life histories of insect pests and the section devoted to farm machinery, attention is specially directed to the results already obtained and their application in practice. A further useful purpose served by the publication is to indicate the interdependence of the various branches of agriculture, and to demonstrate the wide range of interests involved and the widely spread efforts that are being directed towards the improvement of this great national industry.

THE Meteorological Office has an exhibit of its work in the Government Pavilion at the British Empire Exhibition, Wembley, and an account of the exhibits appears in the *Meteorological Magazine* for June. The entrance to the meteorological section is at the back of the Government Pavilion. Numerous instruments necessary for weather records and weather forecasting are on view. A continuous record is given of the direction and speed of the wind over the building obtained from a Dines pressure tube anemograph, and the intensity of the rainfall is recorded by an autographic rain gauge. A balloon meteorograph is exhibited, and there is a large working model of this to show how the results are obtained. The instrument records temperature correctly to 1° C. and pressure correctly to within a few millimetres. The walls are hung with specially prepared diagrams illustrating different branches of the work. The preparation of forecasts is demonstrated by members of the office staff and data are collected by a wireless installation from a great part of the Northern Hemisphere. There can also be seen the meteorological log kept on board H.M.S. *Thrush* when His Majesty as Prince George was in command. The importance of meteorology is evidently being increasingly acknowledged.

IN an article in the issue of *Science* for May 2, Prof. F. Cajori of the University of California disposes of some of the more or less popular legends which have grown up with regard to Sir Isaac Newton and his work. The delay of twenty years in the publication of the law of gravitation was not due to his taking 60 instead of 69 miles as a degree of latitude, but to his uncertainty as to how a sphere attracted a particle outside it. The delay of the Royal Society in publishing the "Principia" was not due to the absence of any reference in it to Hooke's previous statement of the inverse square law, but to Newton's desire to stop publication. He did not believe as Cotes, the editor of the second edition of the "Principia" did, in action at a distance, but postulated a medium requiring time to act. He did not reject the wave theory of light in favour of the corpuscular theory, but made use of the idea of ether vibrations wherever it seemed the more suitable. The authoritative works of Brewster, Horsley, and Rosenberger provide no support for these legends, but this cannot be said of the "Encyclopædia Britannica" article on Newton.

IN our issue of June 28 we recorded the tragic death of two members of the Mount Everest Expedition, Mr. G. L. Mallory and Mr. A. C. Irvine. The information then available was a brief telegram; a dispatch which tells us all that is likely to be known has since appeared in the *Times* of July 5. From Lieut.-Col. E. F. Norton's message it appears that the surviving members of the party were to leave the base camp on June 15 for the Rongshar Valley, there to rest for a short period before starting on the homeward march. All the party were suffering from the effects of the high altitude work, and no further attempt to scale Everest will be made this season. Mr. Odell, who was the last to see the two lost climbers, takes up the story and describes the events leading up to the final attempt. On June 6, Mallory and Irvine left the North Col Camp for Camp V. (25,000 ft.), and the next day they went on to Camp VI. (27,000 ft.), which had been established by Norton and Somervell a few days before. The same day Odell arrived in support at Camp V. On June 8, Mallory and Irvine appear to have started on the last stage of the journey to the summit, and at 12.50, in the course of making a survey of the mountain face between Camps V. and VI., Odell observed two figures moving on the mountain above him, a comparatively short distance from the summit. Odell then returned to the North Col, and with Hazard kept watch for the return of the climbers. As they had not returned on the following day, Odell climbed again to Camp V., proceeding to Camp VI. on the next day, but no trace was found of the missing men. To search further was impossible, and the party had to withdraw. The position in which Mallory and Irvine were last seen was determined by theodolite as 28,227 ft. Odell is of opinion that they achieved success but were overtaken by darkness on the return journey, and with this conjecture it seems we must be content.

IN connexion with an article in our issue of April 12 on foot-and-mouth disease, the statement was made that "no one believes that the disease arises *de novo*." M. C. D. Perrine, of Cordoba, Argentine, writes to ask why this belief is held when it must be supposed that diseases must at one time have originated on the earth. This is no doubt true if one is not limited to time. It is a certainty that diseases like smallpox, leprosy, plague and consumption have existed as long

as we have any historical knowledge, and probably for a much longer time. Syphilis is a disease which was formerly believed to have originated *de novo* or was brought to Spain in 1493. The more modern study of original documents has shown that this is most improbable, and there is an accumulating bulk of evidence that syphilis also is an ancient disease. The more rigorously infective diseases are studied, the more easily can it be proved that they are transmitted in succession through a long series of generations.

AT a time when there are signs of an increasing interest in algæ, algologists in all parts of the world will welcome the appearance of a new periodical devoted entirely to their science. The *Revue Algologique* is edited by Dr. P. Allorge and M. G. Hamel, of the Museum d'Histoire Naturelle, Paris, and these French algologists are to be congratulated on their energy and enthusiasm in launching a new journal. The *Revue* is published quarterly, and is obtainable from M. Gontran Hamel, Laboratoire de Cryptogamie, 63 rue de Buffon, Paris 5e; price in France 25 fr., outside France 35 fr. It will contain reviews of all algological papers, commencing with 1923, and is open for original contributions. The first part now issued is well got up and consists of 96 pages. There are several original articles in French and English.

A REPORT recently issued by the Board of Education deals with the progress of the Science Museum during the years 1921 and 1922. The Museum appears to have been much hindered by lack of accommodation, part of the collections (and particularly that relating to fishery) being stored away; while the task of transferring about half of these to new quarters gave the staff plenty of occupation, new (but inadequate) buildings having been put in hand in 1922 so as to become available in instalments in lieu of space ceded to the Imperial War Museum. In spite of these difficulties, creditable progress was made: a number of new exhibits were incorporated, including a historical collection of electrical apparatus lent by the Institution of Electrical Engineers and one illustrating the history of kinematography lent by Mr. W. Day, the series relating to light road transport and to wireless communication were specially developed, an improved system of indexing was introduced and completed, catalogues were published for the sections dealing with textile machinery, aeronautics and meteorology, and much repairing and preparation of models was carried out in the workshops. A minor piece of work of some importance was that undertaken in connexion with the Eötvös torsion balance in the Museum. To the Science Library more than 5000 volumes and 15,000 parts and pamphlets were added, and a new classification scheme was put into effect. The number of readers averaged less than forty a day. The smallness of this number is doubtless due to the fact that the library is less known to scientific workers than it should be.

THE Report of the International Air Congress held in June 1923 has recently been issued as a portentous volume of nearly 1000 pages, edited for the Committee by Lieut.-Colonel W. Lockwood Marsh (London: Royal Aeronautical Society, 1923. 25*s*.). It embodies a mass of papers and discussion on every field of aeronautical interest, aerodynamics and meteorology, engines and fuels, strength of construction, commercial aviation, legal questions, and medical problems arising out of aeronautical accidents. It is a wonderful record of achievement in so youthful a science. There were gathered together 551 representatives of 21 different nations, but the ex-enemy countries were conspicuous by their absence. This is the more to be deplored since some of the more recent and fundamental advances have been developed by the latter. An international discussion on aerodynamics without Prandtl is like relativity without Einstein. The report demonstrates the useful purpose served in effecting comparisons between the experimental methods pursued in different countries, and stresses the value of standard comparative tests in all existing wind tunnels. Contributors included members of the staffs of the National Physical Laboratory, Royal Aircraft Establishment and of the corresponding institutes in France, Holland, Italy, and the United States. The volume may be taken in fact as the most recent authoritative statement of the present position of aeronautical science both on the theoretical and on the experimental sides. The report is unfortunately marred by a number of misprints in formulæ.

SIR NAPIER SHAW, professor of meteorology in the Imperial College of Science and Technology and formerly director of the Meteorological Office, has been elected a foreign member of the Royal Swedish Academy of Science in respect of his "masterly researches on the domain of meteorology."

A SUPERINTENDENT of Fishery Investigations is required for the purpose of organising a new department of fishery research in the Straits Settlements and Malay States. Particulars of the duties of the post and forms of application may be obtained from the Private Secretary (Appointments), Colonial Office, S.W.1.

APPLICATIONS are invited for two appointments in the Department of Agriculture, Nairobi, Kenya Colony, namely, an agricultural assistant with experience in agricultural practice and ability to carry out crop experiments and to render itinerant and advisory services, and an agricultural chemist able to take charge of the chemical branch and to initiate and undertake research. Applications, upon a prescribed form, must be received before July 15 by the Private Secretary (Appointments), Colonial Office, S.W.1.

THE second annual corporate meeting of the Institution of Chemical Engineers will be held at the Hotel Cecil on Wednesday, July 16, when the president, Sir Arthur Duckham, will deliver his presidential address. During the afternoon session Sir Frederic Nathan will review the work of the Education Committee on "The Training of a Chemical Engineer." The meeting will conclude with a visit to the British Empire Exhibition, and a tour of the Chemical Hall will be made under the guidance of Mr. W. J. U. Woolcock.

THREE Agricultural Inspectors are required for the Agricultural Department, Iraq. Candidates should be honours graduates of a British university, holding a diploma in agriculture, or possessing similar qualifications. The persons appointed will be responsible for work mainly in connexion with cotton development, and there are opportunities for original research in agricultural economics. One of the selected candidates may be appointed Assistant Director of Agriculture at headquarters. It is therefore desirable that at least one of the candidates appointed should have had experience of editorial work in addition to other qualifications required.

MISS C. F. ELAM has been appointed to the research fellowship in metallurgy, of the value of 500*l.* a year for five years, given by the Worshipful Company of Armourers and Brasiers in the City of London, and awarded through the Royal Society. Miss Elam was a student of Newnham College, Cambridge, and has been engaged in research work on the properties of metallic crystals with Prof. H. C. H. Carpenter at the Royal School of Mines for the past few years. She also investigated the method of distortion of aluminium crystals in tension, in conjunction with Prof. G. I. Taylor, at the Cavendish Laboratory, Cambridge, and the results of this investigation formed the subject of the Bakerian Lecture of the Royal Society for 1923.

THE Council of the Royal Society of Arts has awarded the Society's Silver Medals for papers read before the Society during the past session as follows: (*Ordinary Meetings*)—Sir Frank Baines, "The Preservation of Ancient Monuments and Buildings"; Sir Richard A. S. Paget, Bt., "The History, Development, and Commercial Uses of Fused Silica"; Major-Gen. Sir Fabian Ware, "Building and Decoration of the War Cemeteries"; Mr. Frank Hope-Jones, "The Free Pendulum"; Brig.-Gen. Sir Henry Maybury, "The Victoria Dock District and its Roads"; Mr. T. Thorne Baker, "Photography in Industry, Science and Medicine"; Mrs. Arthur McGrath (Rosita Forbes), "The Position of the Arabs in Art and Literature." (*Indian Section*)—Brig.-Gen. H. A. Young, "The Indian Ordnance Factories and Indian Industries"; Sir Richard M. Dane, "Manufacture of Salt in India." (*Dominions and Colonies Section*)—Prof. C. Gilbert Cullis, "A Sketch of the Geology and Mineral Resources of Cyprus"; Sir Frederick Lugard, "The Mandate System and the British Mandates."

Our Astronomical Column.

ENCKE'S COMET.—This is the best known of all the short-period comets, and has been observed at every return for the last century. L. Matkiewicz has taken charge of the computations regarding it that were carried on for a long period by the late Prof. Backlund. He notes that a marked change in the mean motion took place in 1918, similar to that in 1904. Since observations in 1921 were confined to a fortnight, it is very desirable to observe the comet over a long arc at the present return. Its detection in July is possible, and it should certainly be found before the end of August.

The following elements, which include perturbations by Jupiter only, are from *Astr. Nachr.* 5298:

T 1924 Oct. 31, 429 G.M.T.
ω 184° 43′ 43″
Ω 334 · 37 33 } 1924·0
i 12 30 21
ϕ 57 48 28
μ 1074″·092

EPHEMERIS FOR GREENWICH MIDNIGHT.

	R.A.	N. Decl.		R.A.	N. Decl.
July 16.	2h 46m 37s	24° 30′	July 28.	3h 14m 57s	27° 9′
,, 20.	2 55 46	25 20	Aug. 1.	3 25 16	28 8
,, 24.	3 5 10	26 14	,, 5.	3 36 17	29 8

Values of log r, log Δ on Aug. 1: 0·2294, 0·2268. The comet is a morning object, rising 5 hours before the sun in mid July.

TOTAL LUNAR ECLIPSES.—An article by W. J. Fisher in Brit. Astron. Assoc. Journal for May gives useful hints on the observation of total lunar eclipses. These phenomena were for long regarded as of little scientific value. Then opportunity was taken to improve our knowledge of the moon's diameter by making numerous observations of occultations at the darkened limb. Afterwards it was recognised that study of the illumination of the eclipsed moon gave useful information on the average transparency of the air in the regions for which the moon was in the horizon. A map of the circumstances of the eclipse of Aug. 14 next (partly visible in England) makes it easy to locate these regions for every phase of the eclipse. They lie to a considerable extent over Europe, Africa, and South America, so that direct meteorological observations will be available for comparison with those given by the eclipse.

It is suggested that spectroscopic observations with a large lens and short focus might be made during totality; also the use of screens of various colours might enable more exact determinations to be made of the colours of various parts of the disc. The study is an easy and attractive one for amateur observers.

REPORT OF THE BERGEDORF OBSERVATORY.—This Observatory is carrying on an active programme of work in various fields under its director, Prof. R. Schorr. A second appendix to his "Eigenbewegungs-Lexikon" has just appeared, containing 1248 new proper motions, mostly of stars from magnitudes 6 to 9 and Right Ascensions from 0h to 2h; the astrographic and other recent catalogues have been used in preparing it.

The meridian work at the Observatory includes the re-observation of stars in Rümker's Catalogue, of which a revision was recently published.

Dr. Baade uses the reflecting telescope for the photography of minor planets and comets; the comet found by him in 1922 was followed until the early months of 1924. The very interesting planet 944, found by him, which travels all the way from the orbit of Mars to that of Saturn, has received the name "Hidalgo," after the Mexican hero; this is in recognition of the warm reception given to the German Eclipse Expedition to Mexico in September 1923. Masculine names are given only to minor planets with exceptional orbits, such as Eros and the Trojans.

Prof. Schorr is further engaged on the great "Geschichte des Fixsternhimmels," which contains a summary of all meridian work on the stars from 1750 to 1900. The first 2 hours have already appeared. This work was begun by Ristenpart at Berlin, but was interrupted by his departure to South America, where he died.

Research Items.

PALÆOLITHIC SKULLS FROM CAVES IN SOMERSET.—Vol. ii. part i. of the Proceedings of the Spelæological Society of the University of Bristol contains an important communication by Sir Arthur Keith, describing the skulls found in Aveline's Hole, Burrington Coombe, Somerset. This cave, as has been shown by excavations carried on by members of the Society, served as a dwelling-place—and as a burial place—for man in the closing phase of the Pleistocene period. Of the three skulls described, one is dolichocephalic and two are brachycephalic. Notwithstanding this difference, Sir Arthur Keith is of the opinion that they belong to the same race, the variation in length-breadth index being negligible in view of the identity of other characters, notably the high-pitched cranial vault. In this respect they compare very closely with the new Solutré crania and the Chancelade skull. Their discovery is peculiarly worthy of note, as no brachycephalic skulls of palæolithic date have hitherto been found in England. Although they differ in outline very decidedly from the late palæolithic skulls found both at Ofnet and Furfoos, yet in absolute length and breadth they show a close correspondence to those from the latter locality, while at least four of the intermediate series from Ofnet are comparable to them. Sir Arthur Keith regards them as of Azilian date, but Mr. J. A. Davis in his third report on the excavations, which appears in this issue of the proceedings, holds rather that the Aveline's Hole culture represents an isolated survival of Aurignacian into the late Magdalenian times, to which the occurrence of a typical harpoon, previously reported, seems to point.

MOURNING CAPS OF MURRAY RIVER NATIVES.—Mr. Edgar R. Waite, Director of the South Australian Museum, directs attention in vol. ii. No. 4 of the Records of that institution to a point connected with the mourning caps of the Murray River Natives which has hitherto escaped notice. The mourning caps worn by the widow, relatives of the deceased, and others, after a death, were built up of moist clay on the foundation of a net placed on the head of a mourner, usually said to be shaved for that purpose. Such mourning caps were, naturally, adapted to the shape of the head of the wearer, and also show traces of the process of building up, which was done gradually at different times. These were placed on the grave after an interval. There are, however, other forms of mourning caps which show no trace of having been built up on a foundation, and have obviously been made in one operation; also the interior is neither deep enough nor of the shape to fit on the head. It is suggested that they were dummies which were placed upon the grave by those relatives and others who had ceased to wear a clay cap as a sign of mourning, as the widow continued to do, but still used them in their dummy form as a ceremonial mark of respect to the deceased.

THE ANTS OF KRAKATAU.—In *Treubia*, vol. v. Nos. 1-3, Feb. 1924, Prof. W. M. Wheeler describes a collection of ants made during 1919–21 on Krakatau and adjacent islands and sent to him by Dr. K. W. Dammerman. During the great volcanic eruption of 1883 the fauna and flora of Krakatau, Verlaten, and Lang Islands were completely destroyed, and even Sebesi, at a distance of 15 km., seems to have suffered a similar fate. The study of the animals and plants that are gradually repeopling the islands has received considerable attention. In so far as ants are concerned, it appears that Dr. Dammerman has nearly doubled the known forms from Krakatau, and has much more than doubled the number of those known from Verlaten. The previous collector (Jacobson in 1908), however, used less refined methods of collecting so that the increase may not be entirely due to more recent arrivals on the islands. Most of the ants in the Krakatau group are common species of a wide range in the Indomalayan or even in the Neotropical region. They are hardy forms which survive anywhere in warm countries. Dr. Dammerman believes that many insects may have reached the islands as eggs, larvæ or pupæ, on drifting wood or plants, but contends that dispersal by air plays a more important part than is usually attributed to it. It is significant in this connexion that only one species of ant with wingless females is recorded by Prof. Wheeler in the collection; this evidently supports Dr. Dammerman's opinion.

ENTOMOSTRACA FROM COLORADO.—G. S. Dodds describes the Entomostraca collected by Dr. H. L. Shantz in 1903 and 1904 on the slopes of Pikes Peak (10,000 to 12,000 ft.) and from ponds on the plains near Colorado Springs (6000 to 7000 ft.) supplemented by other records from the State of Colorado (Proc. U.S. Nat. Mus., lxv.). Situated astride the Continental divide, Colorado is the meeting-place of eastern and western faunas, and includes portions of five life zones. The 31 species of Entomostraca found by Shantz fall into three natural groups: 13 found on the plains but not on the mountains; 9 found only on the mountains; and 9, able to live in both warm and cold water, found in both groups of lakes. A similar tripartite division was observable in those collected in Colorado by the author. A graphic representation of the altitudinal range of these species is given, and the author dwells on the significance of these records, especially when it is remembered that the extremes of the two groups of lakes are separated at the most by not more than 10 miles, and yet support Entomostracan faunas as distinct as if separated by hundreds of miles in a north and south direction. The several species common to the two groups stand in strong contrast to the others, and serve to emphasise the fact that temperature may be an effective barrier for some species, but not for others. The paper concludes with a list of the lakes and the species of Entomostraca found in each, with other details.

FEEDING AND DIGESTION IN NEPHROPS.—C. M. Yonge (*Brit. Journ. Exp. Biol.*, vol. 1, pp. 343-389, 1924) gives an account of the mechanism of feeding and the process of digestion in *Nephrops norvegicus*. He describes the anatomy, histology and mode of action of the various parts of the alimentary tract, and records that the enzymes of the hepatopancreas digest starch, glycogen, sucrose, maltose and lactose; the amylolytic ferment finding its optimum in a neutral medium at a temperature of 57° C. The hepatopancreatic secretion also contains a fat-splitting enzyme and a powerful proteolytic enzyme. As in other crustacea, the hepatopancreas stores fat and glycogen, but apparently not calcium.

THE LARVÆ OF THE PEA CRABS.—The zoea larvæ of the pea crabs (Pinnotheridæ) have been studied by O. W. Hyman (Proc. U.S. Mus., vol. 67, Art. 7, 1924) at Beaufort, North Carolina. Ovigerous females were collected and kept in the laboratory until hatching of the eggs took place. The eggs hatch at nightfall. The only feature that is common to the zoea larvæ of this family and serves to distinguish them from the zoeæ of other families is the minute

size of the antenna. In other families the arrangement and size of the spines of the carapace are usually distinctive features of the zoea, but in pinnotherids there is no uniformity in this respect; spines may be prominent or entirely absent. The author gives a key to the known zoeæ. The complete history of metamorphosis has not been followed in any species, but it seems probable that the pinnotherids have at least three—probably four—zoeal stages followed by a megalopa and by the young crab.

TERTIARY CIRRIPEDIA FROM HAITI.—The specific distinctions in Balanus being based upon the opercular plates, no species can be well established until these are known. In their absence the characters of the walls and basis have to be relied upon, and in forms from a restricted area fairly satisfactory results can thus be obtained. Working on these lines, Dr. H. A. Pilsbry describes three forms from the Miocene of Haiti (Proc. U.S. Nat. Mus., lxv.), of which one is doubtful, one described as a new subspecies, and the third as a new species. At the same time, he admits that in the absence of the opercular plates comparison with European Tertiary species is impossible.

PŒCILOZONITES, RECENT AND FOSSIL.—Those interesting land snails belonging to the genus Pœcilozonites are peculiar to Bermuda, and though the living forms have long been known, it is only within comparatively recent years that the fossil ones have been studied. Some of these fossil forms are now dealt with by Dr. H. A. Pilsbry (Proc. Acad. Nat. Sci. Philad., lxxvi.), who proposes two new subgenera: Gastrelasmus for the species having a long, entering palatal lamella, type *P. circumfirmatus* (Redfield), and Discozonites, type *P. blandi*, n.sp. Several new species and varieties are described and illustrated by text figures. Lieut.-Col. Peil, who has recently written on the same subject, states, however (Proc. Malac. Soc. Lond., xvi. pp. 18, 19), that in the living *P. circumscriptus* the internal lamella is sometimes absent.

IMPORTANCE OF MANGANESE IN PLANTS.—J. S. McHargue (*Journ. Agric. Research*, xxvii. No. 6) claims to have obtained data showing conclusively that manganese is an essential element in plant economy and performs an important function, perhaps catalytic, in the synthesis of chlorophyll. Other experiments are being conducted to discover whether manganese is also a vital factor in animal nutrition. In view of the results obtained, and also of the fact that manganese is found in greater quantity in those plant and animal tissues which are richest in vitamins, the author is led to assume that a relationship exists between this element and the vital factors contained in these tissues.

STATISTICS OF INDIAN WHEAT PRODUCTION.—The importance of the application of statistical methods to agricultural problems is exemplified in an article on "Wheat Forecasts in the Punjab" (H. K. Trevaskis, *Agric. Journ., India*, xix. Part III.). Originally crop statistics were based on the requirements of the land-revenue system, but the abnormal conditions created during and after the War led to the development of statistical methods of estimating whether the stocks of wheat in hand were sufficient to feed the great Indian population. At the present time the Punjab wheat statistics, with their bearing on the possibility of export, are of direct importance to the Liverpool wheat market. Forecasts are prepared, of which the first two deal only with the area covered by wheat and cotton, and the last two are estimates of the quantity of the crop actually to be handled. The various methods of estimation of crop yield are discussed, together with the statistical possibilities of estimating the amount required for home consumption. It is suggested that if a census of the stocks in hand could be made at the end of the financial year, it would be increasingly possible to estimate the accuracy of the figures for crop yield and consumption, thus providing more trustworthy data to be considered in controlling the disposal of the wheat crop.

NIGERIAN COAL MEASURES.—Bulletin No. 6 of the Geological Survey of Nigeria deals with the Nigerian Coalfields. Section 1, Enugu Area, is by A. D. N. Bain, with appendices by R. Bullen Newton and Prof. A. C. Seward (London: Crown Agents for the Colonies, 1924. 10s. net.) It shows that there are a considerable number of thin seams, but in most of the localities there is a seam of 5 ft. to 6 ft. in thickness, which is evidently workable. A number of analyses are given, showing that the coal is a non-caking coal fairly high in volatile matter and with only moderate ash contents. It is, however, possible that some of these coals may be found to produce a useful coke under suitable conditions. Apparently the coal is a good flaming coal and, therefore, well suited to reverberatory furnace work, so that it would appear to be quite possible to smelt locally the tinstone produced. The total output in 1922 is given as 110,785 tons, and it is shown that the development of collieries in this portion of West Africa is likely to be of very considerable economic importance.

COMPUTATION OF ESTUARY TIDES.—A paper entitled "Estuary tides: a comparison of methods of computation," by Dr. Bell Dawson, the Superintendent of the Tidal and Current Survey of Canada, is given in No. 41 of the Bulletin of the National Research Council, Washington. The subject under discussion is the accuracy of prediction of the times of high- and low-water at stations where the tides are much affected by the presence of shallow water, as at Quebec. The mechanical harmonic prediction as hitherto used for Quebec, though based on the analysis of 19 years' records, gives average errors in high- and low-water times of 26 and 10 minutes respectively. For Father Point, a station 180 miles nearer the ocean, the predictions are similarly based on 15 years' records, and the corresponding average errors are each 6 minutes. To improve on the predictions for Quebec, Dr. Dawson has applied his principle of variable differences, periodic (though not in general harmonic) in the synodic, anomalistic and declinational months. This is a principle which he has used extensively for many years to deduce tidal predictions at a large number of stations from the harmonic predictions for a small number of standard ports. In his present investigation, he regards Quebec as a secondary port having Father Point for its standard, whereas previously Quebec had been regarded as a standard port. By this means the average errors in the predicted times of high- and low-water at Quebec are reduced to practically the same as those for Father Point.

IONISATION IN SOLUTIONS.—In recent years the view has been expressed by several investigators that strong electrolytes are practically completely ionised even at moderate concentrations, and that variations usually put down to varying ionisation are due to varying activities of the free ions. Attempts have been made by Milner to relate the activity to the electrostatic forces between the ions, and, more recently, by Debye and Hückel. In the May number of the Journal of the American Chemical Society Prof. A. A. Noyes gives an elementary deduction of the formulæ, and a comparison with experiment. The

individual behaviour of different ions, in contradiction to the theory, again emerges, but the general agreement is of a very striking character.

ATMOSPHERIC POLLUTION.—In addition to the completed results published in the annual report of the Advisory Committee on Atmospheric Pollution, arrangements have been made for the circulation, month by month, of abstracts showing the records from deposit gauges, so that earlier information can be obtained. The results for April, according to the *Meteorological Magazine* for June, show that in the centre of Liverpool the deposit amounted to 34 gm. per square metre, while on the outskirts of Southport the deposit was only 2 gm. per square metre. In the City of London it was $13\frac{1}{2}$ gm. per square metre. Abstracts can be obtained from the Atmospheric Pollution Committee, 47 Victoria Street, S.W.1.

A NEW SOURCE OF SHORT ELECTRIC WAVES.—The second pamphlet issued by the State Electrical Research Institute, Moscow, is an account by Mrs. A. A. Glagolewa-Arkadiewa of a new method of producing short electrical waves ranging from 0·125 mm. to 50 mm. in length according to the materials used (see also NATURE, May 3, p. 640). This range includes the wave-lengths 2-4 mm. recently produced by Nichols and Tear (*Physical Review*, vol. 2, 1923), and covers the gap between them and the longest produced by Rubens and Baeyer, 0·2-0·34 mm., a dozen years ago by the method of residual radiation. The new method consists in interposing in the spark-gap of the exciting induction coil a paste of fine aluminium or brass particles mixed with heavy machine oil which is carried on the rim of a wheel like a rubber tyre. The wheel dips into a tank of the paste, and by its revolution the paste in the spark-gap is continually renewed. The waves sent out have sufficient energy to allow their wave-lengths to be measured by the mirror method of Boltzmann.

ESTIMATION OF RADIOACTIVE SUBSTANCE BY γ-RAYS.—Dr. W. Bothe describes, in the *Zeitschrift für Physik* for May, observations made at the Reichsanstalt with an apparatus in which varying thicknesses of lead, in the form of a series of concentric hollow cylinders with a total thickness of 11·0 cm., can be interposed between the preparation, which is placed in the axis of the smallest cylinder, and the ionisation chamber. This is a cylindrical sheet iron vessel, with a central cylindrical hollow space having the same radius as the largest lead cylinder, which fits into it. The inner electrode of the chamber is a cylindrical ring of sheet iron concentric with the lead cylinders, and is connected with a gold leaf electroscope on the top of the chamber. The arrangement is very sensitive, so that good readings can be obtained with the full thickness of lead. The absorption coefficients of the γ-rays from the substances to be investigated, in equilibrium with their disintegration products, are 0·50 cm.$^{-1}$ for radium, 0·62 cm.$^{-1}$ for mesothorium, and 0·46 cm.$^{-1}$ for radiothorium; so that it is possible for a mixture of the last two to behave like pure radium, and it might be concluded that it is impossible to distinguish between these two cases by the absorption method. Curves have, however, been prepared, showing the relation between the radium equivalent for the pure substances, and for different mixtures, and the varying thicknesses of the lead filter; in these the "normal value" of the preparation, obtained through 0·5 cm. of lead, was taken as unity. The curves show that it is possible to estimate the amounts of the constituents in any mixture of two of these substances, since even with a mixture of mesothorium and radiothorium, in which the absorption is "equal" to that of radium, the curve is not identical with that of radium, but cuts it at three points, and is easily distinguished from it. Such a mixture together with radium may give a curve from which it is impossible to deduce the relative amounts of the three constituents; but, apart from this, the composition of any mixture of these substances can be estimated from its curve.

WASTE HEAT BOILERS AND VERTICAL RETORT GAS INSTALLATIONS.—Results of tests carried out by the Gas Investigation Committee of the Institution of Gas Engineers at the works of the Birmingham Gas Department, and embodied in the twelfth Report submitted by the Committee to the annual meeting of the Institution, show that by the introduction of the practice of heat-recovery from waste gases in waste heat boilers the thermal efficiency of gas production in normal working with continuous vertical retorts is increased from 60 per cent. to about 66 per cent.

PULVERISED FUEL.—A paper on "Pulverised Fuel and Efficient Steam Generation" read by Mr. D. Brownlie before the Institution of Electrical Engineers last December has already been noticed in NATURE, January 12, p. 62. The paper in full with the discussions which have followed at various centres appears in the Institution's Journal for May. These are interesting because the subject of the relative merits of mechanical stoking and pulverised fuel firing is to-day very controversial and was extensively debated by many speakers. Furthermore, the paper dealt with a single system using a central pulverising plant, and there were a number of advocates of systems employing "unit pulverisers" to each furnace. Again the possibility that the ejection of coal ash would cause a dust nuisance in the densely populated areas of Great Britain aroused much concern. It was urged in reply that this dust is so fine as to be carried far away from the installation so that its final destination is unknown.

PRODUCTION OF TOWNS' GAS BY THE REGENERATIVE GASIFICATION SYSTEM.—A plant for the production of towns' gas from coal by the regenerative complete gasification system introduced by Messrs. M. W. Travers and Clark, has been in operation at Aylesbury since February 1923, and was described at the annual meeting of the Institution of Gas Engineers. The installation has about three times the output of a carburetted water gas plant which previously occupied the site on which it has been erected. Coal is carbonised in an upper section of the plant by internal heating effected by direct transference of heat from hot gases passed through the coal. The resulting coke is gasified by the alternate action of steam and air in the lower section of the generator. Heat is recovered from the blow gas in a regenerator, from which the heated circulating gas passes to mix with the water-gas passing from the lower to the upper section of the plant during the run. The output of gas from the plant is approximately 184 therms of gas of calorific power about 360 B.Th.U. per cubic foot per ton of dry coal gasified. By carburetting, the calorific power of the gas is raised to 420 B.Th.U. per cubic foot. The overall efficiency of the complete gasification process is 55·3 per cent., which compares favourably with an estimated efficiency of about 46·7 per cent. characterising the more usual practice consisting of a combination of a carbonisation process with the production of water gas. Operating charges, excluding cost of coal but including costs of carburetting and purification, amount to 1·39*d*. per therm delivered into the gasholder.

Relativity at the International Congress of Philosophy, Naples.

SINCE the inception of the International Congresses of Philosophy in 1900, it was arranged that such gatherings should be an opportunity for philosophers and men of science to meet on common ground for discussion. Nowadays, philosophers cannot claim to have a complete system unless they account for the various branches of science in their synthetic explanation of things. They must understand what men of science have found out for themselves and give a value to their discoveries in their theories of knowledge. It is quite appropriate then that they should be helped in their efforts by the searching analysis scientific workers have made of their own labours. There cannot be any antagonism between philosophy and science; one completes the other and each is strengthened by the support of the other.

It was a gratifying spectacle to see metaphysicians, logicians, mathematicians, physicists, and biologists sitting together in the great halls of the University of Naples. These meetings formed an integral part of the International Congress of Philosophy, which was arranged at Naples at the beginning of May, under the presidency of Prof. Aliotta, on the occasion of the seventh centenary of the foundation of that University.

Unavoidably the outstanding question under discussion during these joint meetings was Einstein's theory of relativity. Prof. Einstein was, however, prevented from attending the Congress at the last moment. Nevertheless, some valuable papers were read at the sittings of the section of History and Philosophy of Science. Under the chairmanship of Prof. Marcolongo of Naples and then of Prof. Hadamard of Paris, various aspects of the theory of relativity were developed. Prof. Cartan (Paris), in a paper on "The Theory of Relativity and the Generalisation of the Notion of Space," gave an interpretation of Einstein's tensor by means of the notion of curvature and that of the torsion of a curved space, using also Levi-Civita's definition of parallelism. Prof. Hadamard put forward some interesting considerations on the equations of cylindric waves already studied by Volterra. M. Nordmann, of the National Observatory of Paris, dealt with the controversy between Einstein and Bergson with reference to the relativity of time. He contended that Einstein's memoir, published in 1905, gives no ground for criticism, and that Bergson's remarks are based on certain statements, made by Einstein in his popular work, which are open to controversy.

Mr. Zaremba of Cracow, in a paper, "The Theory of Relativity and Experience," pointed out some logical failures of Einstein's theory, and expressed the opinion that at the present stage it cannot be said that experience is for or against it. Prof. Kopff (Berlin) developed some suggestive relations between astronomy and Einstein's conceptions.

Prof. Enriques (Rome), in a paper entitled "A Criticism of the Notion of Time," maintained that time is not only, as according to Kant, the order of internal sensibility, but also that it contains the idea of a natural standard of measure. The analysis of the postulates referring to such a standard reveals the unity of physical forces and the hypothesis that time is independent of space. The rejection of this hypothesis leads to the theory of relativity. Prof. Giorgi acknowledged that the mathematical and logical structure of Einstein's theory is absolutely perfect and quite compatible with natural phenomena. But he does not think that this theory has had sufficient verifications in proportion to its importance and ambitions. Prof. Severi expounded a new method of arriving at Lorentz's classical formulæ by means of an analysis of the concept of time. Prof. Timpanaro, speaking on "The Value of the Theory of Relativity," proposed a new theory, which he called etheral-ballistic, according to which natural phenomena can be explained with as much exactness as with the theory of relativity.

The great opponent of Einstein's ideas was Prof. La Rosa, of Palermo, who spoke on "Some Astronomical Facts against Einstein's Theory based on Ritz's Hypothesis." He showed how to explain several phenomena of variable stars according to Ritz's hypothesis where the velocity of light is compounded with that of force. Einstein's theory, he said, is only one of the possible relativistic ways of interpreting natural phenomena. There is, besides, what he called the "ballistic method," which has much experimental evidence in its favour. The ballistic hypothesis states that the velocity of light can be compounded with that of its source; and when applied to the theory of the double stars it leads to some very interesting and unexpected results. For example, on the basis of the ballistic hypothesis, all double stars having a distance and a period satisfying certain limitations, must appear to us as variable stars. Following up this line of thought, Prof. La Rosa offers a general explanation of the phenomena of double and variable stars.

Among other papers on the philosophy of science, we must mention those of Prof. Vorovka (Prague) and Sittignani, who discussed from different angles Poincaré's epistemological theories, and Prof. Driesch's communication on "The Philosophy of Organic Life." Prof. Hans Driesch, the most authoritative representative of vitalism, explained, with an abundance of examples, that the phenomena of life cannot be accounted for simply by means of physico-chemical processes. Biology shows us that a multicellular organism can be divided up into many parts without stopping its development. A machine cannot be submitted to the same operation with the same results. There must be, therefore, in every living organism a cohesive agent, which he calls "entelechy," the function of which cannot be analysed at the present stage of science, but obviously it causes the organism to develop whatever be the mishaps it may suffer.

In his paper on "The Specification of the Straight Line," Dr. T. Greenwood developed the logical arguments which lead him to state in a new way the problem of the characterisation of the Euclidian straight line by means of a single axiom which he calls "The Postulate of Null-Curvature." He establishes this postulate by means of a new hypothetico-deductive system of axioms based on the notions of "point" and "distance," and uses it to prove the two ordinary postulates of the straight line. This method, which is very simple in itself, has many advantages in the logical, the pedagogical, and the scientific field.

The numerous papers, more than two hundred, read at the Naples Congress did not permit of any discussion, mainly because the time available was not proportionate to their number. This, however, shows admirably the passionate devotion with which Italian thinkers study science and philosophy; and the more so as, besides the International Congress of Philosophy, an Ophthalmological Congress, a Gynæcological Congress, and a joint meeting of the Association of Scientific Societies of Italy, were sitting concurrently at Naples, whilst there was a Sociological Congress and a Eugenics Congress at Rome, and a Geographical Congress at Genoa. Yet, to all those who were able to go to Naples—unfortunately there were not many visitors from Great Britain—the visit will rank among the most pleasant memories of their academical career.

THOMAS GREENWOOD.

The National Physical Laboratory, Teddington.

ANNUAL INSPECTION.

ON Tuesday, June 24, the General Board of the National Physical Laboratory made the annual visitation to the Laboratory. As is usual on this occasion, a large number of members of scientific and technical societies and institutions, members of Government departments and of industrial organisations were also invited to the Laboratory, the whole of which was open for inspection. The visitors were received by Sir Charles Sherrington, chairman of the General Board, Sir Arthur Schuster, chairman of the Executive Committee, and the Director of the Laboratory.

An extensive programme of exhibits had been arranged to illustrate the general character of the work of the Laboratory in addition to features of particular or novel interest.

In the Aeronautics Department the wind channels were shown in operation on various problems which are engaging the attention of the Department. In the 7 ft. wind channel, the airflow round a monoplane aerofoil was being investigated with the object of examining the fundamental assumptions of the Prandtl theory of vortex motion. Special hot wire anemometers, in which the wires are placed along instead of across the air stream, are used to observe the direction and velocity of the air stream. The existence of eddies behind cylinders in an air stream was made evident audibly, by the amplification in a two-valve amplifier and telephone receiver, of the fluctuating potential differences produced by the cooling effects of the eddies, in a hot platinum wire placed behind the cylinder. In the 14 ft. channel, apparatus was on view designed and constructed in the Department for measuring the head resistance of stream line bodies in a wind channel and in the William Froude National Tank. By using the same apparatus in both air and water, the method eliminates the interference between the apparatus and the body under test, so that comparison of the results is possible, and for the first time accurate deductions of the importance of "eddies" in channel work can be made. Other exhibits included the whirling arm and the electrical method of determining the theoretical stream lines for an inviscid fluid moving past a flat plate, both of which were mentioned in the description of the exhibits at the last visitation.

In the Engineering Department, a special electrical dynamometer designed to produce full torque from 20-1700 revolutions per minute was exhibited. The field magnet frame was mounted on roller bearings, and it is claimed that the power transmitted (up to 100 h.p.) is measured to one-tenth of 1 per cent. Another interesting exhibit was that of apparatus for measuring and recording the relative movement of chassis and axles in vehicles. This work has developed in connexion with a general research on springs for vehicle suspension. The effect of shock absorbers in damping vibrations has also been investigated. Apparatus for determining the effect of keys and keyways on the endurance of shafts and for testing brake lining materials was also on view.

In the Metallurgy Department a high frequency induction furnace was shown in which metals can be melted in vacuo without danger of contamination from circumambient gases. The electrolytic preparation of iron and chromium of 99·98 per cent. purity was also on view. In the Wernher Building, interesting microphotographs showed the behaviour of mild steel and brass under the action of cutting tools. These indicated the great importance of the orientation and shape of the tool in determining the ease with which the metal is cut, the character of the finished surface and the wear on the tool.

In the William Froude National Tank a model 10-knot single-screw cargo steamer was shown under test for propulsive efficiency. The thrust and torque of the propeller and the resistance of the hull in water are measured. The plant for making accurate models of ship hulls of a mixture of paraffin wax and beeswax, and also of screw propellers, was on view, and a model propeller was shown under construction.

In the Metrology Department standard weights, including new weights made of stellite, were shown. Various measuring machines designed and constructed in the Department were also on view. These included the "millionth" comparator and tilting level comparator for the comparison of standard length gauges to an accuracy of a millionth of an inch, an improved travelling microscope and the Blythswood diffraction grating ruling engine. Various methods of the application of interferometry to metrological work were shown together with sources of light producing a series of monochromatic rays covering a wide range in wave-length.

A very large number of exhibits was shown in the Physics Department, including a new form of all-metal mercury vapour pump, capable of extremely rapid exhaustion, and a standard optical pyrometer of the disappearing filament type for use up to 3000° A. The most interesting were in connexion with the sound section, in which a photographic method of studying the acoustical properties of rooms was shown. A vertical section of a model of a building was placed horizontally in a trough of water, and trains of water waves were emitted from a point corresponding to the position of a speaker. By projecting light vertically through the glass bottom of the tank, the shadow picture of the disturbance at the surface of the water could be seen on a screen above. This was photographed at certain definite times, enabling the progress of any wave to be followed in its travel across the model of the room, and in its reflections (echoes) from the walls or architectural details. The results have shown in a very convincing manner how in buildings the structural details can interfere with the propagation of speech in certain parts, and the department has been able to make valuable suggestions to improve the acoustical properties. Experimental sounds are very often produced by electrical methods, and an interesting method of study of the purity of the waveforms of electrical oscillations, which are later transformed into auditory oscillations, has been developed. It involves the use of the Weston cathode ray oscillograph, the spot of which describes a circle on the fluorescent screen if the oscillations are sinusoidal.

The Radiology Section exhibited apparatus for the determination of absorption co-efficients, using a metal X-ray tube of high output, for the rapid determination of the lead equivalent of X-ray protective material, and various apparatus for the determination of the crystalline structure of metals and alloys, several of which have been worked out and are of great interest in connexion with the collateral work of the Metallurgy Department on the same alloys. In the Optics Section a new flicker photometer for comparing lights of different colours and improved spectrophotometric apparatus were shown. A constant temperature room has been added to the equipment of this section since the occasion of the last annual visitation and should result in the eventual determination of important optical constants to a greater accuracy than has been possible hitherto. The room is cooled by air from a refrigerat-

ing plant or warmed by air passing over electric heaters; cooling or warming to any desired temperature is automatic through electrical resistance thermometers and relays, and maintains the temperature at any point constant to 0·01° C.

In the Electricity Department, Alternating Current Division, the arrangements for the accurate measurement and calibration of A.C. instruments and of high voltage insulating materials were shown. An interesting phenomenon in dielectric hysteresis was exhibited in which a rotating electric field caused a cylinder of celluloid to rotate. The greater the energy loss due to imperfection of insulation quality, the greater is the torque and the speed at which the insulation material will rotate, except that owing to friction the speed cannot reach that of the rotating field (50 r.p.m.). In the Direct Current Division the association of a hydraulic pressure with endosmosis was exhibited. An electric circuit of 100 volts was earthed under a glass funnel full of damp earth surrounded by water. In the experiment shown, the passage of a few milliamperes caused the water to ascend from the earth to a height of 12 ft. in a tube connected to the funnel. The phenomenon is of interest and importance in the choice of the most suitable methods of earthing electrical machinery and power cables.

The Photometry Division showed exhibits illustrative of the careful work and research which is contributing to the improvement of artificial illumination of all kinds. The experimental building for determining the best methods of utilising daylight was also shown in operation, and a new instrument for measuring daylight factors shown. In the Electrical Measurements Division apparatus showing the accuracy which has been developed in the measurement of frequency in radio oscillations was exhibited. A radio station for the transmission of standardised frequency has been equipped and was open for inspection. In the Wireless Division, apparatus was shown which enables the direction of both the electric and magnetic forces in electromagnetic waves to be determined separately, so that the direction of the wave front is accurately known. This is of interest in connexion with the Beveridge antenna, the action of which is due to the existence of tilt in arriving electromagnetic waves. Among the standard testing apparatus demonstrated were a panel for measuring all the static characteristics of receiving valves, and a set for examining the amplifying properties of audio frequency intervalve transformers. In the latter arrangement the actual voltage amplification produced by a stage comprising one valve and one transformer is measured by a comparative audibility method at any frequency from 250-4000 cycles per second. Using standard types of amplifying valves this measurement enables a study to be made of the frequency distortion introduced into speech-frequency amplifiers by the iron cored intervalve transformers. Other apparatus was shown by which the input and output of any standard type of amplifying detector can be measured, thus enabling a complete study to be made of the behaviour of an amplifier at either radio or audio-frequencies. H. B.

The Natural Resources of Russia.

THE Transactions of the Committee for the Study of Russia's Natural Resources, attached to the Russian Academy of Science, include works of varying type:

(1) Separate monographs—"Precious Stones of Russia," by A. E. Fersman; "A Household Fungus," by I. A. Makrinoff.

(2) Studies of Russia's natural resources—"Russian Wax," by N. M. Koulagin; "Medicinal and Tanin-producing Plants of the Tavricheskaya Province," by B. N. Lioubimenko; "Tea and its Cultivation in Russia," by the same author; "Kendyr (Apocynum Sibiricum Pall)," by I. A. Rajkova; "Russian Sources of Fuller's-earth," by A. E. Fersman; "Beet," by E. V. Kostezky and E. J. Zalensky; "Iodine Containing Lakes of the South of Russia: Eltonskoe, Bakou Iodine Lakes and the Saki Lakes," by N. N. Efremoff, G. G. Ourazoff, and A. E. Fersman; "Bozon," by V. G. Khlopin; "Absorbing Properties of Russian Clays," by P. E. Zamiatchensky; "The Caspian Pilchard," by B. I. Meisner; "Phosphates of the Ukrain," by V. N. Chervinsky; "Tihvin Bauxite," by A. D. Stopkevitch, V. I. Ikskul, and B. P. Ovsiannikoff; "Honey," by I. A. Kabloukoff; "Mica," by I. I. Ginsbourg.

(3) Periodicals—vol. i. of "Wind as Driving Power," by M. M. Rikacheff, A. V. Voznesensky, and T. N. Klado; vol. iv. of "Useful Ores," including: "Silver, Lead and Zinc," by K. I. Bogdanovich, "Gold," by K. I. Bogdanovich, "Vanadium," by K. I. Bogdanovich and K. A. Nenadkevich; "Sulphuric Pyrite," by J. B. Samoiloff; "Russian Coals," with an introduction by P. I. Stepanoff—a co-operative work of 30 specialists of the different coal regions of Russia; "Naphtha and Ozokerite," by D. B. Goloubjatnikoff; "Phosphates," by J. B. Samoiloff and A. D. Arhangelsky; "Felspar," by A. E. Fersman; "Ores of Aluminium," by K. K. fon Foht; "Selenium," by F. B. Bragalia; vol. vi. of "The Animal Kingdom": "Mammals and Birds," by A. A. Silantieff and E. K. Souvorov; "Fishes," by V. I. Meisner, N. M. Knipovich, V. K. Soldatoff, I. N. Arnold, I. D. Kouznezoff, A. I. Golovkin, and A. J. Nedoshivin; "Cattle," by S. A. Ivanoff; "Poultry," by M. I. Diakoff.

(4) Reports on the Activities of the Committee: Minutes xxvii.-xxxiii., reports on 1918 and also reports from 1915 to 1920; and

(5) News from the different scientific institutions attached to the Committee: Institute for the Study of Platinum and other Rare Metals, Institute of Physico-Chemical Analysis.

All the above-mentioned bulky and valuable material in connexion with the natural resources of Russia has been published since 1918–1920. With exceptional feeling and respect one turns over these pages, written by Russian men of science, with a great love of their country, and in circumstances of the greatest privations. These privations affected not only their personal well-being, but also such things as the possibility of getting necessary scientific literature and reagents, and even the temperature of the laboratories. We can get an idea of the hardships they endure by occasional phrases we sometimes meet in their works. We learn, for example, that the temperature of the laboratory of the Polytechnical Institute in Petrograd was the same as that of the street, because the laboratory could not be heated; that the photographic section of the expedition for exploring the Karabougai Gulf could only make negatives because they had no suitable printing paper and equipment to be able to make use of silver bromide paper, etc. In spite of, or perhaps even because of these awful surroundings, Russian men of science have devoted themselves with praiseworthy neglect of self to their scientific work.

"In the dark and even perhaps seemingly hopeless days of Russian everyday life, I have tried," says

Prof. Fersman in the introduction to his book on "The Precious Stones of Russia," "to fly away into the world of the beautiful stone. I want to carry away my friends and the friends of stones from the heartrending surroundings of their everyday life, into another world, and in a number of talks I have tried to show the riches of Russia in her precious stones."

At the head of this Committee there stands a Council of the most prominent men of science. The president of the Council is a member of the Academy —Prof. V. I. Vernadsky—while another member is N. S. Kournakoff, vice-president. The Committee was founded by the Russian Academy of Science in 1915. As Russia during the War was cut off from the world's market, it had to make use of its own resources, and increased knowledge of these natural resources became necessary.

M. Vernadsky expressed this idea in the following words in 1915: "We are in such a position as regards a whole number of our natural products, that we even do not know if we have them, and if we have got them, then in what quantities—all this is because we have got used to getting them from abroad and have given up looking for them in our own country." Russia, therefore, needed a systematic survey of its natural resources in order to become self-supporting. The problem of developing the natural resources has been put forward by the Committee ever since as a great national goal.

The author of the project of founding a special institute for the geographical study of Russia, A. A. Gavriloff, says in May 1919, "The world's economy must pass through an epoch of highly organised national economies, in which the highest possible organisation of production and useful development of the natural resources of the country reduce to a minimum the competition between the different undertakings within the country. In this way is obtained increased economic strength and means for productive competition with other nations. It is only natural that Russia must needs follow along this path."

The Committee of the Academy of Science has rendered a great service to Russia by collecting and systematising so much material in connexion with the natural resources of Russia. Since 1915 to 1920 it has published 13,469 pages of scientific works. This Committee has likewise rendered a service to world economy; every foreigner who wants to take to Russia his capital or his knowledge for the development of Russia's natural resources will find in these works clear and definite answers to the questions which interest him in connexion with different branches of industry.

Limitations of space forbid a detailed account of the works mentioned above. Special attention may be directed, however, to the brilliant work of Prof. Fersman on the precious stones of Russia, and to works with most detailed and careful information on Russian coal, naphtha, platinum, and gold. Attention may also be directed to the energetic action of the Committee in supporting new industries started in Russia before the War began, such as the production of radium and vanadium from the Tuja-Mujunski mines. Before the War this was undertaken and carried out by the Fergan Society of Rare Metals. With the nationalisation of the mines this young undertaking might otherwise have been killed.

The Committee for the Study of Russia's Natural Resources has formed a special section in connexion with rare metals and radioactive substances. This includes such prominent men of science as Vernadsky and Kournakoff, both of whom are members of the Academy, and Profs. Jakovkin, Joffe, Veber, Sokoloff, Lialin, and Khlopin. What is even more, this section has obtained a Government grant, and has started works in connexion with the production of radium. Information relating to this interesting section of the work of the Committee will be found in the Transactions of the Committee of the Academy of Science for 1918.

The Geological History of South-Eastern Australia, with Special Reference to the Carboniferous and Permian Periods.[1]

By C. A. SUSSMILCH.

ROCKS of definite Archæozoic age occur only over a limited area in the western part of south-eastern Australia; they contain the important silver-lead-zinc ore-deposits of the Broken Hill District. Proterozoic strata are limited also to the same area; these contain glacial tillites which have usually in the past been considered Cambrian, but they are probably of pre-Cambrian age. No undoubted Cambrian strata are known to occur in New South Wales.

Ordovician strata are very extensively developed, both in New South Wales and in Victoria: they consist mainly of claystones with some fine-grained sandstones, and contain an abundant graptolite-fauna. Both Lower and Upper Ordovician strata are found in Victoria, but so far only the latter have been identified in New South Wales. Silurian strata are developed over extensive areas in New South Wales, particularly in the southern and central parts of the State, and extend also through the centre of Victoria; in addition to claystones, there is a considerable development of limestones, individual beds ranging up to 550 feet in thickness. An abundant coralline fauna is preserved in these limestones and there are also many brachiopods and hydrozoa.

[1] Substance of a lecture delivered before the Geological Society of London on May 21.

The sea appears to have retreated from the land at the close of the Silurian Period in south-eastern Australia, but renewed transgressions of limited extent took place early in the Devonian Period. The sedimentation which took place in these areas in Lower and Middle Devonian times was accompanied by very extensive deposition of lavas and tuffs, this being one of the important volcanic epochs of south-eastern Australia. Thick coralline limestones were also deposited during that age. Important crustal movements took place at the close of the Middle Devonian times, followed by an extensive transgression of the sea in New South Wales in the Upper Devonian Period, a transgression which extended from the present south-eastern coast almost to the far western boundaries of the State. In the strata deposited in this epicontinental sea an abundant brachiopod fauna is preserved, together with numerous fish-remains. Important crustal movements took place at the end of the Devonian Period, which brought about a complete withdrawal of the sea; much of south-eastern Australia has not since been beneath the sea.

Early in the Carboniferous Period a geosyncline developed in north-eastern New South Wales, and in this was first deposited a series of marine strata in

the latter part of Lower Carboniferous times. Following a withdrawal of the sea, an extensive series of terrestrial beds was deposited in this area in Middle and Upper Carboniferous times; these terrestrial strata consist mainly of conglomerates, volcanic rocks (lavas and tuffs), and glacial beds, of an aggregate thickness approaching 10,000 feet. The glacial beds are of such a thickness and volume as to imply intense and long-continued glaciation. Associated with these beds is a characteristic Rhacopteris fossil flora.

In Permian (Permo-Carboniferous) time an alternating series of marine and freshwater beds was deposited in the north-eastern part of New South Wales, and these extend far northwards into eastern Queensland. The freshwater beds contain the most productive coal-measures of Australia, and associated with the coal-seams is the characteristic Glossopteris flora. The glacial conditions of the Carboniferous Period continued also far into the Permian Period, but with apparently reduced intensity. The Permian Period closed in north-eastern New South Wales and south-eastern Queensland with pronounced orogenic movements, accompanied by granitic intrusions; but elsewhere in New South Wales and throughout Victoria and Tasmania, no earth-folding took place at that time.

In the Trias-Jura Period the whole of eastern Australia stood above the sea, and extended far east of the present shore-line. Upon this land there developed a number of large lake-basins in which several thousands of feet of freshwater strata were deposited, and in some areas productive coal-measures were formed. In the Cretaceous Period a transgression of the sea began in the north, and extended southwards over central Queensland into northern New South Wales, and well into central Australia. At the beginning of the Tertiary Period a tilting of the Australian continent on an east-and-west axis caused the Cretaceous sea to retreat northwards, and allowed of transgression taking place over considerable areas in the south, incidentally separating Tasmania from the mainland.

The close of the Tertiary Period was marked by a great epeirogenic uplift in eastern Australia, which produced the existing tablelands trending parallel to the eastern coast of Australia. The elevation of these tablelands was accompanied by extensive block-faulting. During the Pleistocene Period, limited high areas in New South Wales and Tasmania supported glaciers and ice-sheets; more recently, a subsidence of the land (or raising of sea-level) drowned the shore-line to an extent of about 200 feet, and still later an upward movement of the strand-line of some 10 to 20 feet has taken place.

The Japanese Earthquake of September 1, 1923.

SHORTLY after the Japanese earthquake of September 1, 1923, Mr. Takeo Kato, on behalf of the Imperial Earthquake Investigation Committee, made reconnaissances through the districts of violent shocks, especially those around Sagami Bay. He has published a preliminary report on this field study in the Journal of the Geological Society of Tokyo (vol. 30, No. 361), including some definite estimates of the loss of life and property. In Tokyo, though not a house escaped some damage, the number of houses that collapsed owing to the shock was comparatively small. The latest official statistics place the number of houses destroyed by fire in Tokyo at 316,087, the number of killed at 67,052, of injured at 32,583, and of missing at 38,980. The shocks were far stronger at Yokohama, and strongest of all in the districts around Sagami Bay. In six towns along and near the borders of the Bay, 84,300 houses were destroyed and 26,370 lives were lost.

From seismographic and other evidence, the epicentre of the great earthquake seems to lie in Sagami Bay, about midway between Oshima and Hiratsuka, near the mouth of the Sagami River, and probably a little nearer the latter place. In the two months following this shock, the number of after-shocks was more than 1350; there were 365 on September 1, and 289, 173, and 143 during the next three days; afterwards the normal decline in frequency was manifested. The epicentres of these after-shocks lay at different places more or less remote from the main one. A few minutes after the great earthquake sea-waves swamped the shores of Sagami Bay, from Shimoda in the Idzu peninsula to Misaki and Uraga in the Miura peninsula, and also along the southern part of the Boso peninsula. They caused much damage only at Ito, Atami, Kamakura, and a few other places, where the height of the waves ranged from 20 to 40 feet. No conspicuous sea-waves were seen in Tokyo Bay. No great fault-scarps or traces have been observed, but in the islet of Hatsu-shima, off Atami, a fissure was traced for about half a mile, with in some places a displacement of 3 feet or more, running in the direction N. 30° W. Another, rather more than a mile in length, was found near Nagasawa in the Miura peninsula. Both fissures may be regarded as minor faults of the main fault along which the great earthquake originated.

A remarkable upheaval of the ground took place, it is said, within a few minutes after this earthquake, over an area of about 2000 square miles, including the islet of Hatsu-shima, the headland of Manazuru, the northern border of Sagami Bay, the Miura and Boso peninsulas. The greatest upheaval (about 8 feet) occurred at Tomizaki, along the southern coast of the Boso peninsula, and it is remarkable that here the ground settled down more than a foot within one month after the upheaval. According to the soundings made by the Navy Hydrographic Office, conspicuous changes in depth, of 50 fathoms and more, have occurred at various places in the deepest portion of Sagami Bay. Soundings are still being carried out in the Bay, while many levelling parties of the Military Department are engaged in ascertaining the changes in elevation throughout the earthquake area.

It is worthy of notice that the epicentre lies in the deepest region of Sagami Bay. This trough, which has a N.N.W. direction from Oshima to Hiratsuka, appears to be the southern continuation of the valley of the Sagami River running in the same direction. Moreover, tectonic lines in this direction are numerous, as indicated by the coast borders, valley courses, etc., and the minor faults at Hatsu-shima and Nagasawa run nearly parallel to this direction. The origin of the earthquake is attributed to a great compressive force, probably from the east, which has been accumulating for a long time. The last great earthquake in the district occurred on November 22, 1703, and seems to have originated in a great fault along the same tectonic line, the epicentre lying apparently a little to the south of that in 1923. A similar upheaval of land is recorded at that time.

C. D.

University and Educational Intelligence.

BIRMINGHAM.—At the annual Degree Congregation held on July 5 the Chancellor (Viscount Cecil of Chelwood) conferred the honorary degree of LL.D. on His Excellency Count de St. Aulaire, The Rt. Hon. Reginald M'Kenna, Sir Charles Sherrington, Sir John Bland Sutton, Sir Arthur Keith, Sir Henry Fowler, Sir Graham Balfour, Prof. Samuel Alexander, Prof. G. H. Hardy, Prof. F. Gowland Hopkins, and Prof. P. F. Frankland.

There were 4 successful candidates for the degree of Ph.D. and 18 for M.Sc. In the Honours Schools the degree of B.Sc. was conferred on 3 in mathematics, 8 in physics, 17 in chemistry, 1 in zoology, 3 in botany, 2 in biochemistry, and 26 in engineering, mining, and metallurgy. For the ordinary degree of B.Sc., 62 candidates were presented, and for the degrees of M.B., Ch.B., 29.

Mr. A. W. Nash has been appointed professor in oil mining. Educated as a civil and mechanical engineer, Mr. Nash has had fifteen years' experience in oil mining in Persia, Burma, Egypt, Russia, Hungary, Rumania, and Poland, and for the last two years he has been lecturer in oil mining in the University.

Mr. H. Beckwith Whitehouse has been appointed professor of midwifery and diseases of women. Mr. Whitehouse was educated at Malvern College and St. Thomas's Hospital Medical School, and among other posts he has held that of Hunterian professor to the Royal College of Surgeons, England.

Dr. James Maclure Smellie has been appointed lecturer in pharmacology and therapeutics; and Mr. Bernard G. Goodwin has been appointed assistant to the chair of surgery.

Miss Mabel Geraldine Carter has been appointed temporary lecturer in biology.

Some anxiety has been shown in the local press as to the openings available for the graduates in science now leaving the University. Prof. G. T. Morgan, in a letter to the *Birmingham Post* of July 5, directs attention to the fact that graduates of the University find employment more readily in other large towns than in Birmingham itself. Prof. Morgan observes that he himself is frequently consulted by local manufacturers in search of advice in chemical problems, and he suggests that many of these inquirers would find it highly advantageous to select a chemical staff of their own from the ranks of trained chemists who are being produced yearly in the University.

CAMBRIDGE.—Dr. J. Chadwick, Gonville and Caius College, has been appointed Assistant Director of Radioactive Research at the Cavendish Laboratory. Mr. H. Thirkill, Clare College, and Dr. C. D. Ellis, Trinity College, have been appointed demonstrators in experimental physics; Mr. F. W. Dootson, Trinity Hall, Mr. H. M'Combie, King's College, Mr. W. G. Palmer, St. John's College, and Mr. A. J. Berry, Downing College, have been appointed demonstrators in chemistry. Mr. J. C. Wallace has been re-elected to a junior fellowship at Emmanuel College. H. E. Baker, Corpus Christi College, has been awarded the Wiltshire Prize. Frank Smart Prizes are awarded to R. G. Tomkins, Trinity College (botany), and to G. P. Wells, Trinity College (zoology).

LEEDS.—Headingley Wesleyan College and its extensive grounds have been acquired by the University, and at the beginning of next session will be opened as a University Hall of Residence for 120 men students.

LONDON.—At a meeting of the board of the Middlesex Hospital on July 2, it was announced that Mr. S. A. Courtauld, for many years a generous supporter of the Middlesex Hospital and its Medical School, has given 20,000*l.* to endow the University professorship of anatomy in the Medical School.

IN connexion with the London (Royal Free Hospital) School of Medicine for Women, a 1916 bursary of the annual value of 50*l.* for five years is offered to a student who has matriculated and who wishes to enter the school in October next to begin a full course of study for a medical degree. Particulars of the bursary are obtainable from the Warden and Secretary, 8 Hunter Street, W.C.1.

MR. D. B. J. WALLACE, county agricultural organiser for Devon, has been appointed principal of the East Anglian Institute of Agriculture at Chelmsford.

FOLLOWING upon the death of Prof. J. G. Longbottom, head of the Department of Mechanics, the Governors of the Royal Technical College, Glasgow, have decided to amalgamate the Departments of Mechanics and Mechanical Engineering under Dr. A. L. Mellanby, who will in future be the professor of mechanics and mechanical engineering. Dr. W. Kerr, lecturer in mechanical engineering, has been appointed associate professor in the Department. Dr. Kerr is known for his work on the "Steam Friction of Turbine Wheels" and on the "Critical Speeds of Revolving Shafts," and in collaboration with Prof. Mellanby has published numerous papers dealing with problems connected with steam turbines.

THE University of Sydney loses this year the services of Mr. H. E. Barff, its Warden and Registrar for forty-two years, who is resigning office on account of ill-health. The abnormal increase in the number of students after the War imposed a severe strain on the administrative staff of the University and on its finances. The report for 1923 shows that the number of students in attendance in that year (2755) and in each of the four preceding years was almost, if not quite, double the number in the last year before the War. Since 1920, however, the number has been decreasing. The Sydney University Union, the oldest society of its kind in Australia, and one that challenges comparison with the Oxford and Cambridge Unions, celebrates this year its jubilee.

THE report of proceedings of the Annual Conference of the Universities of Great Britain and Ireland held in May last has been published by the Universities Bureau, 50 Russell Square, W.C.1 (price 1*s.*). The subjects discussed are: Directions in which universities might profitably develop, at the present time, were funds available; the Ph.D. Degree as an encouragement to higher study and research; universities and research in relation to the development of the natural resources and industries of the Empire; interchange of university teachers and students. We have already, in our issue of May 17, given a summary account of the proceedings. The full report covers 63 pages and includes, in addition to the speeches that were delivered, an important paper embodying the substance of a speech which Sir Frederic L. Nathan intended to make on the dependence of the British Isles and the Empire generally on imports from foreign countries and the steps which should be taken to remedy this. There is also a letter from Sir Robert Robertson, Government Chemist, on the difficulty of finding suitable candidates for posts of chemist and agricultural chemist in the Government laboratories in the Colonies.

Early Science at the Royal Society.

July 6, 1663. Dr. Wilkins undertook to engage Dr. Power to make that magnetical experiment here, which he had made in the country, according to his written account sent to Dr. Croune for the society, viz., of altering the polarity of a heated and cooled iron, by repercussing the two ends, and of destroying all the magnetism thereof, by striking such an iron in the middle.

1664. Capt. Taylor related, that he had known a Frenchman, who had a secret of tempering and hardening iron so that it would not rust; adding that the steel of a gun, which he produced, had been put in salt water, and was not affected with any rust; and that the same gun had not been oiled since it had been made, viz., for three years. The artist employed a certain water, which he concealed the ingredients of, wherein he quenched the iron eight or ten times, in order to reduce it to this condition.

July 8, 1663. Dr. Charleton presented the society with the plan of the stone antiquity at Avebury, near Marlborough, in Wiltshire, suggesting that it was worth the while to dig there under a certain triangular stone, where he conceived would be found a monument of some Danish king. Col. Long and Mr. Aubrey were desired to make farther enquiry into it.

1675. Mr. Hooke shewed an experiment concerning the resistance of air to a ball moved with and without an expanded area; of which he was desired to bring in a particular account in writing.

1685. A letter of Mr. Musgrave dated at Oxford, July 4, 1685, was read, mentioning, that a great part of the university being in arms [On occasion of the Monmouth rebellion] the Philosophical Society there was broken up for some time.

July 10, 1672. The Society intending to make a recess for some time, the members were desired, that as many of them, as could conveniently, would meet on Fridays in the afternoon at Gresham-college, to discourse of philosophical matters, and prosecute experiments; among which were recommended—Such, as might determine the queries lately sent by Mr. Newton, which involve his theory of light.—Such, as might improve Mr. Newton's reflecting telescope; and particularly to see finished a four-foot telescope of that kind, already recommended to Mr. Cock.—Such observations as might confirm those of Signor Malpighi about the existence of certain tracheæ, or spiral fibres in vegetables, that contain air: as also to endeavour to the finding out of peristaltic motion, affirmed.

1679. Divers discourses were occasioned about the several ways of tanning leather.

July 11, 1666. Dr. Croune produced a letter, written by Nicholas Stens, from Rome, mentioning the emulation between Divini and Campani about optic glasses. That Campani had been mistaken in some of his observations, taking the spots adhering to the body of Jupiter for the shadows of his satellites.

1667. Mr. Hooke reported that Dr. Croune had received from Mr. Richard Townley, Mr. Gascoyne's instrument for measuring the diameter of the stars with great exactness; which instrument was afterwards shewed to the society, with the models of some others.—Mr. Hooke mentioned, that he had invented an instrument of this kind, but upon another principle which would perform the same things better, with more certainty and more ease.

July 12, 1682. A proposal was read of Mr. John Collins for the printing a book of algebra [Thomas Baker's "The Geometrical Key"]. This was well approved of after a long debate concerning it.

Societies and Academies.

LONDON.

Royal Society, June 26.—J. W. **Nicholson**: The electrification of two parallel circular discs. The paper deals with the general application of spheroidal harmonics to the problem of two bodies not belonging to the same confocal system. The special case of two circular discs is reduced to a mathematical necessity for the determination of an infinite set of coefficients in a series involving Bessel Functions of half-integral order. This in turn is reduced to an integral equation of a new type, the kernel of which is

$$K(x, y) = \frac{\sin a(x+y)}{x+y} + \frac{\sin b(x-y)}{x-y}.$$

The equation is solved exactly, and exact expressions are found for the capacity of the double-disc condenser, and for the coefficients of capacity and induction of two discs with any charges.—J. F. **Fulton**: The influence of initial tension upon the magnitude and duration of the mechanical response in skeletal muscle. When the unexcised gastrocnemius, sartorius or semitendinosis muscle of the frog is stimulated through its cut nerve under various degrees of initial passive stretch by 50 break shocks delivered at 70 per second, so long as the circulation in the muscle remains vigorous, the following features are to be observed in the successive responses: The greater the initial tension within physiological limits, (*a*) the greater is the plateau tension of the resulting tetanus; (*b*) the longer the time of ascent to the plateau; (*c*) the greater the duration of the plateau *after* cessation of the stimuli ("after-action"). It seems that the general shape of the tetanus curve is determined by the rate of migration of the H-ions of lactic acid, and that the after-action represents the time spent by the ions in migrating from the place of their origin to the contractile interfaces upon which they act. The enhanced duration of the after-action with increasing tension is believed to result from the effect of the increased internal viscosity of the muscle upon the migration rate of the ions.—J. R. H. **Coutts**, E. M. **Crowther**, B. A. **Keen**, and S. **Odén**: An automatic and continuous recording balance. (The Odén-Keen Balance.) An improved form of automatic and continuous recording balance has been devised by combining electromagnetic control with the addition of small weights. A magnet suspended from one arm is attracted by a solenoid-current which is adjusted to maintain equipoise by the automatic movement of a contact along slide wires. The position of this contact is sufficient to define the effective weight, and is recorded on a rotating drum. On reaching a fixed point the contact is brought back to its original position by the addition of a small phosphor-bronze ball to the balance pan, and the cycle of operations recommences. The records consist of a series of stepped curves and a very open scale is obtained so that the apparatus can be used with no appreciable loss of sensitivity up to the maximum load for an analytical balance. Further, the sensitivity can be very simply adjusted for recording either rapid or slow changes of weight.—R. W. **Lunt**: Chemical studies in gaseous ionisation. Pt. I.: This communication constitutes the introduction to a series. Ionisation in hydrogen is produced by the corona due to alternating electric fields of frequency $1{\cdot}5 \times 10^7$. A new analysis of the Siemens ozoniser is advanced which affords a ready determination of the voltage gradient in the gas, and of the current carried by the ions in the gas. The mean intensity of ionisation is calculated from an equation relating the conduction

current in the gas to the known motions of ions and electrons in hydrogen. Pt. II.: The interaction between hydrogen and carbon dioxide due to the ionisation produced by alternating electric fields of frequency $1{\cdot}5 \times 10^7$ has been examined under a variety of conditions. An equimolecular mixture interacts giving a water gas equilibrium, which is also attained by exposing mixtures of carbon monoxide and water vapour to the discharge. In no case has it been possible to detect the formation of formic acid or formaldehyde. The equation used in Pt. I. for the determination of the mean intensity of ionisation in hydrogen has been extended to the determination of this quantity in the above-mentioned water-gas equilibria.—D. W. **Dye**: A self-contained standard harmonic wavemeter. The wavemeter provides a series of harmonics as a result of exactly timed electrical impulses which operate on a highly selective oscillatory circuit. The impulses are provided by either of two multivibrators. One of these has an impulse frequency of 1000 cycles per second, and is controlled in frequency by a valve-maintained tuning fork. The other multivibrator has normally a fundamental frequency of 20,000 cycles per second, and is controlled by the help of the 20th harmonic of the low-frequency multivibrator. The selector circuit consists of a specially designed variable air condenser and a set of six inductance coils of small damping decrement. The six scales are direct reading in frequency, uniform, and cover the range 10 to 1200 kilocycles. Owing to the master control of the tuning fork over both multivibrators, all the frequencies available are accurate to at least one part in ten thousand, and are not dependent upon the calibration, setting, or constancy of any electrical circuit. Intermediary subsidiary harmonics are readily obtainable from the apparatus; by the aid of these, the gaps between the main harmonics can be reduced to about 2 per cent. in frequency in the worst case.—W. L. **Bragg**: The influence of atomic arrangement on refractive index. It is assumed that the atoms, which are polarised by the electric force associated with the light wave, are spherically symmetrical ions, that the elastic yield of the ion to the polarising force is defined by a coefficient λ, which is a constant for the ion concerned, and that the polarising force may be taken to be that at the atomic centre. The birefringence of calcite and aragonite, using the X-ray determinations of crystal structures, has already been explained quantitatively. That of aluminium oxide is now explained. An attempt is made to attack the reverse problem of using the refractivity data to give information about crystal or molecular structure. A comparison of refractivity in carbonates and nitrates indicates a contraction of the NO_3 group as compared with the CO_3 group, and a value for the distance between nitrogen and oxygen atomic centres is obtained.—A. V. **Hill** and H. S. **Gasser**: The dynamics of muscular contraction. In a muscular contraction carried out with various speeds of shortening, the work done is a function of the speed, decreasing as the latter increases. This was previously attributed to the viscosity of the muscle substance. It might depend, however, upon some kind of nervous adjustment carried out through a proprioceptive reflex. The experiments were repeated on an isolated muscle stimulated directly; the same dependence of work on speed of shortening occurred. This is a characteristic, therefore, of the muscle fibre. If the work decreases with increase of speed, so also must the force of contraction, and one striking result obtained is that a quick release of a muscle through 10 to 15 per cent. of its length causes an instantaneous disappearance of tension, which then redevelops along a curve similar to the initial curve of tension development. The viscosity of a muscle increases some fifteen times while the muscle is being stimulated, and it is possible on a viscous elastic model to repeat the phenomena. The fundamental mechanical response of muscle is probably a sudden instantaneous reversible colloidal change which passes off rapidly, the external mechanical response following the internal change, but lagging behind it owing to viscosity.—G. S. **Currey**: The colouring matter of the blue pansy. The anthocyanin pigment of the blue pansy "Emperor William" consists of violanin, and the blue colour of the petals is due to the fact that the pigment is present in the form of its potassium salt; it occurs to the extent of ca. 6·3 per cent. by weight of the dried petals (=1·14 per cent. of the fresh petals). The yellow sap-pigment consists of the flavonol, rutin (viola-rutin). As crude glucoside, it is present to the extent of ca. 9·68 per cent. by weight of the dried petals (=1·75 per cent. of the fresh petals), the actual amount of pure rutin being 50·4 per cent. by weight of the crude substance, *i.e.* the dried petals contain approximately 4·9 per cent. of pure rutin (=0·88 per cent. of the fresh petals).—R. **Snow**: Conduction of excitation in stem and leaf of *Mimosa pudica*.—R. **Azuma**: Thermodynamic phenomena exhibited in a shortening or lengthening muscle. When an excited muscle is released—whether doing external work or not—during the earlier phase of tension development, the heat production is increased; when released at a later phase the heat production is diminished. When an excited muscle is stretched, the converse result is obtained. This suggests that the effects are reversible and thermodynamic in origin, superimposed upon the ordinary irreversible reactions of muscular activity. These conclusions confirm and extend recent observations by Fenn.—H. **Taylor**: The ionic nature of hæmoglobin. By laking the corpuscles by freezing and thawing and suspending in them a collodion membrane which contains a dilute salt solution and is impermeable to hæmoglobin, a Donnan equilibrium is obtained after about three hours. The membrane potential difference is measured and this gives the factor relating the ionic concentrations of the laked corpuscles and those of the crystalloid solution inside the collodion membrane. From this potential difference and an analysis of the crystalloid dialysate, the concentrations of the hydrogen and chlorine ions in the laked corpuscles have been determined. The potential differences found indicate that the hæmoglobin is behaving as an anion over the range of physiological importance. The normality of the hæmoglobin ions present indicates the maximum amounts of carbon dioxide the blood can further take up as bicarbonate.—J. **Stephenson**: On the blood-glands of earth-worms of the genus Pheretima. The blood-glands of three species of Pheretima consist of numerous small spherical follicles within the hinder part of the pharyngeal mass, and on the dorsal side of the œsophagus. A fully developed follicle consists of a fibrous capsule, a cup-shaped layer of nucleated protoplasm, a loose mass of cells within the cup, and a blood-sinus on the convexity of the cup, between this and the capsule. A blood-vessel leads off from the sinus, and another from the opposite pole of the follicle. The follicle is the seat of manufacture of blood-cells and hæmoglobin. The vascular system in annelids and in the groups derived from annelids, and possibly in other groups also, has a double origin; its peripheral portion has been evolved independently of its more central and contractile portion. The analogies between the development of the vascular system in Oligochætes and Vertebrates are convergences, and imply no genetic relationship between the two phyla.—H. Muir **Evans**: Supplementary note on the poison gland of Trygon.—E. M. **Crowther** and

A. N. **Puri**: The indirect measurement of the aqueous vapour pressure of capillary systems by the freezing-point depression of benzene. The freezing-point of benzene is depressed by an amount which is strictly proportional to the aqueous vapour pressure of an insoluble material with which it is in equilibrium, provided that surface energy is not one of the factors determining the vapour pressure of this material. The method is rapid and accurate when applied to substances such as sulphuric acid-water mixtures and certain salt hydrates. With capillary systems such as soil, the equilibrium is reached more slowly and the apparent vapour pressures show a systematic deviation which is the same for soils of widely different types. By assuming that a fraction of the water in such cases is held in micropores and making allowance for the effects of the changes in surface energy on the introduction of an additional liquid phase, it is possible to account for this deviation.—B. **Cavanagh**: Activity-measurement by the partition method. I. A new way of applying the partition-ratio is suggested as an indirect means of precise activity-measurement. Precise measurements are made of a partition-ratio at extremely low concentrations, and preliminary measurements, in the case of lithium chloride between amyl alcohol and water, are recorded, in which the normality, N/8000 (in the alcoholic phase), has been reached. The method consists essentially in the piecemeal preparation of a large amount of the phase to be analysed, and the concentration (for chemical estimation) of the solute therefrom, by a process of piecemeal extraction. The method depends on the possibility of calculating exactly, and applying by successive approximations, a correction for the amount of the solute evading extraction. Approximate values have been obtained, for the first time, for the activity coefficient of lithium chloride in amyl alcohol, at normalities ranging from 0·2 to 0·0001.—J. E. **Jones**: On the determination of molecular fields. Pt. I. By applying the methods of the kinetic theory to a new molecular model, a new theoretical formula for the coefficient of viscosity of a gas has been obtained. In the case of argon, the difference between theoretical and experimental values is nowhere greater than 0·6 per cent. over the whole range of the observations (−180° to 180° C.). Pt. II. The equation of state of a gas has been calculated for a molecular model consisting of repulsive and attractive fields, each according to an inverse power law. The formula for the *second viriel coefficient* thus obtained contains existing formulæ (for a monatomic gas) as special cases. The force constants of a gas are obtained from a comparison of the theoretical formula with observational material on the equation of state. In the case of argon, more than one molecular model will explain the facts.—C. J. **Smith**: An experimental study of the viscous properties of water-vapour. The viscosity of superheated water-vapour over the range of temperature 100°-260° C. has been determined. The method involves the transpiration of the superheated vapour through a capillary tube, determining the pressure at its ends and the mass of the vapour transpired. The variation of the viscosity with temperature can be represented by Sutherland's formula. The dimensions of the water molecule obtained are in accordance with previous investigations for other gaseous hydrides.—E. M. **Crowther** and J. R. H. **Coutts**: Discontinuity in the dehydration of certain salt hydrates. The changes in weight on rapidly drying certain salt hydrates have been recorded continuously by means of the Odén-Keen automatic recording balance. With thin layers of small crystals of copper sulphate pentahydrate and barium chloride dihydrate, the rate of evaporation shows a very marked minimum value at points corresponding to the composition of definite lower hydrates. An explanation of the observations is advanced on the basis of Langmuir's theory that heterogeneous reactions proceed only at the actual phase boundary. No evidence of discontinuities was found in the rehydration of anhydrous copper sulphate.—W. R. **Dean**: The elastic stability of an annular plate. A plane circular annular plate is under uniform shearing forces applied at its edges, and the problem is treated by the methods of the theory of thin shells. Plates with clamped edges in which the ratio of outer to inner radius exceeds 3·2 are discussed. With the analysis given, a certain type of uniform tensional stress can be allowed for in addition to the uniform shear.—R. C. **Johnson** and W. H. B. **Cameron**: The effect of argon on certain spectra. Investigations have been made of the effect of argon on spectra associated with carbon, oxygen, and sulphur; while in certain respects the action of argon and helium is similar, there are also profound differences. It has not been found possible to reproduce the "comet-tail" bands in high pressure argon, but the "triplet system" of carbon is isolated by both the inert gases. An effect of a similar type due to argon has been observed in connexion with sulphur dioxide. A band spectrum of the latter (obtained otherwise only with difficulty) was brought up strongly in the presence of high pressure argon.—G. R. **Goldsbrough**: On the possible ellipticity of Saturn's ring. Maxwell showed that a single circular ring of particles surrounding the planet Saturn would be in relative equilibrium, provided the mass of each particle was sufficiently small compared with the mass of Saturn. This result is extended to the case of an elliptical ring. By properly placing the particles on the ellipse, by allowing the ellipse to rotate slowly in its plane, and the particles to vibrate about their mean positions, then the elliptical ring is a possible dynamical form. For sufficiently small values of the mass of the particles, and for values of the eccentricity not too great, the elliptical ring will be "ordinarily" stable.—E. C. **Titchmarsh**: The double Fourier series of a discontinuous function. The object is to discuss the behaviour of the double Fourier series which represents a function of two variables, at a point where the function is discontinuous. Such a double series is not necessarily convergent in the general sense; but if it is summed in special ways, *e.g.* by rows or by columns, different sums may be obtained, depending on the values of the function in particular regions surrounding the point considered.

Geological Society, June 4.—Dr. J. W. Evans, president, in the chair.—H. H. **Swinnerton**: On a new catopterid fish from the Keuper of Nottingham. Excavations made at Woodthorpe, near Nottingham, passed through the lowest beds of the Keuper Waterstones, and brought to light numerous well-preserved remains of fossil fishes belonging chiefly to the genus Semionotus, together with specimens of a small fish which proved to be a new species of the genus Dictyopyge. This fish is only 4·5 cm. long, and slightly more than 1 cm. deep. In osteological characters it resembles the Eugnathidæ rather than the Palæoniscidæ. The pectoral girdle, however, has an infraclavicle, a feature which is diagnostic of the Catopteridæ. The detailed study of this new species confirms the usually accepted opinion that the Catopteridæ, although classed with the Chondrostei, approach the Protospondyli.—C. E. **Tilley**: A preliminary survey of metamorphic zones in the Southern Highlands of Scotland. A preliminary metamorphic survey of the Dalradian sediments enclosed within a tract extending from Dunkeld in Perthshire to the western side of Lower Loch Fyne (Argyllshire), and reaching from the Highland Border to the Ben Lui Schists that structurally overlie the Loch Tay Lime-

stone (16 miles across the strike), has been made. The important lines of dislocation, such as the Loch Tay Fault, the Luib Fault, the Tyndrum Fault, etc., displace not only the stratigraphical horizons, but also the metamorphic zones, and in the same direction. Where the boundaries of the zones cross areas of marked topographic relief, information should be provided by the trace of the zone surface. The Braes of Balquhidder, near Loch Earn, are thus favourably situated, and examination shows that the boundary-surface (isograd surface) of the almandine zone is there inclined at low angles to the north-west.

Optical Society, June 12.—Col. L. E. W. **van Albada:** Wide-angle ortho-stereoscopy: its optical, practical, and psychological advantages. In the methods used, the objects appear to the observer in their natural sizes and correct spatial relation to each other. These methods are based on the theories of Wheatstone and Helmholtz. The introduction of exaggerated perspective or other unnatural effects is avoided when the stereoscopic photographs are viewed through lenses which have nearly the same focal lengths as those by means of which the pictures were taken, and provided that the stereoscopic lenses are free from distortion. A new type of wide-angle finder made to the author's design gives a clear image over about 85°, with perfect definition up to the edge of the field. —R. J. **Trump:** Binocular vision and the stereoscopic sense. In the appreciation of distance, neither the convergence of the eyes, the visual focus, nor the variation of these accommodations as the eyes sweep over the field, plays any vital part. The recognition of a familiar type of perspective system is important, even to the extent of over-riding the evidence of binocular parallax, when the two come into conflict. This may be shown by reversing the mounting of stereoscopic photographs, or by preparing stereo diagrams in which the perspective is not in accord with the parallactic displacements. Parallax is uncertain, or even breaks down, when not assisted by perspective. There therefore appears to be no "mechanism" of stereoscopic vision dependent upon binocular parallax, but the perception of distance is a psychological function, involving the interpretation of all the details in the images in the two eyes, in the light of previous association and experience.—T. **Smith:** A general solution of the first order aberrational equations. The general equation by which the properties of the component parts of a compound optical system are determined is put into a new form. Solutions are obtained consisting of terms containing arbitrary constants together with any particular solution. The particular solution itself is the sum of two parts, one of which is independent of the corrections required in the complete instrument, while the other contains only the terms which express these special conditions.

CAMBRIDGE.

Philosophical Society, May 19.—Mr. C. T. Heycock, president, in the chair.—C. D. **Ellis:** The high energy groups of the magnetic radium-*C* β-ray spectrum. The magnetic β-ray spectrum of radium-*C* has been remeasured and the absolute energies of the lines found to an accuracy of 1 in 300. Some of the γ-rays giving these lines have energies so great as two million volts, but yet no evidence is found of any abnormal conversion, all the prominent lines being due to conversion in the *K*, *L*, *M*...electronic levels. This renders it possible to find the wave-lengths of the γ-rays. The results bring out the importance of considering the origin of the γ-rays.—R. H. **Fowler:** The statistical theory of dissociation and ionisation by collision, with applications to the capture and loss of electrons by α-particles. The statistics of general two- and three-body processes of interaction by collision are surveyed. In order to preserve standard equilibrium conditions, a definite relation must be satisfied between the number of two-body collisions which lead to any particular type of dissociation (or ionisation), and the number of three-body collisions which lead to recombination by a process which is the exact replica of the process of dissociation with a reversed time scale. This relation is used to study the laws of capture and loss of electrons by α-particles through the interaction of the field of an atomic core. The complete theory predicts Rutherford's V^5-law for the ratio of double-charged to single-charged α-particles, and gives the correct numerical value of this ratio if we may assume, as is reasonable, that the density of lightly bound electrons inside an atom is of the order 10^{24} per c.c.—D. R. **Hartree:** The spectra of some lithium-like and sodium-like atoms. By means of some theoretical relations between spectra of different atoms ionised to such an extent that their electron structures are the same, the position of lines of the spectra of some lithium-like and sodium-like atoms is estimated. In several cases these calculated lines can be correlated with lines observed by Millikan in the hot spark spectra of the corresponding elements. Lines of the spectra Be II, B III, C IV, and possibly N V and O VI, of lithium-like atoms, and of the spectra P V and S VI of sodium-like atoms, are so identified.—H. W. B. **Skinner:** The relative absorbing powers of the *L*-levels for radiation of varying wave-length. The experiment consisted in photographing the fluorescent *L* spectrum of an element using X-rays of varying wave-length to excite it. A change in the relative intensity of a pair of lines shows that the relative absorbing powers of the L_{I} and L_{III} levels depend on the wave-length of the absorbed radiation. This confirms a result recently obtained in a different way by H. Robinson. Hence the well-known λ^3 law of absorption of X-rays does not apply to an *individual L* level.—H. **Hartridge:** Are the overtones of musical sounds always harmonic? There are at the moment two rival theories: one holds that the voice overtones are harmonic, the other that they are not. Evidence available at the moment appears to be in favour of the latter view, not only for the human voice but also for most musical instruments when performing normally.—H. **Hartridge** and F. J. W. **Roughton:** Further developments in the technique for the measurement of the velocity of very rapid chemical reactions. Two different improvements have been effected: (*a*) to make the apparatus available for the investigation of chemical reaction of greater velocity; (*b*) to employ other methods, beside optical ones, for the determination of the stages arrived at by the reaction at different instants of time from its commencement. With regard to the former, it is now possible to make accurate measurements of mono- and bi-molecular reactions half completed in one-thousandth of a second. With regard to the latter, temperature changes in a moving fluid brought about by a chemical reaction can be ascertained by means of thermo-couples.—E. G. **Dymond:** On the measurement of critical potentials of gases. A method of measuring excitation and ionisation potentials is described in which the current-voltage curves are automatically differentiated. This increases the sharpness of the bends in the curves, and results in increased sensitiveness of measurement.—G. F. C. **Searle:** (1) An optical interference method of measuring Young's modulus for rods. A vertical steel rod is deflected by a load suspended from a horizontal arm attached to its upper end. Two horizontal metal plates are soldered to the steel rod and the lower plate carries a lens, the upper surface of which is

convex. The upper plate carries three adjusting screws against which a horizontal plane glass plate is held by springs. An opening in the upper plate allows the observer to view the Newton's rings formed between the lens and the glass plate when suitable illumination by sodium light is provided. The load and the lens are on opposite sides of the rod, and thus as the load is increased and the rod is bent by the bending moment, the distance between lens and plate is increased and the Newton's rings contract. For each ring that disappears at the centre, the distance between lens and plate increases by $\frac{1}{2}\lambda$, where λ is the wave-length employed. (2) A recording gyroscope. A vertical shaft carries a block to which is attached a horizontal axis. The axle of a cycle wheel is carried by a frame turning about this axis. When the wheel is spun and the proper precessional angular velocity is given to the vertical shaft, the plane of the wheel remains vertical. The upper part of the vertical shaft carries a smoked drum on which the record is made by two styles each operated by an electro-magnet. From the record taken can be found (1) the time of one complete revolution in precession, and (2) the number of revolutions of W about its own axis during that time.—D. H. **Black**: Some electrical properties of liquid sulphur. Films of distilled sulphur were obtained between two cones and the conductivity measured at various temperatures up to 200° C. It was found that the conductivity varied in a similar manner to the viscosity. The conductivity of liquid sulphur seems to be electrolytic in character.—T. M. **Cherry**: (1) The integrals of differential equations. (2) Poincaré's theorem on the non-existence of uniform integrals of dynamical equations.—H. W. **Richmond** and F. **Bath**: Loci having two systems of generating spaces.—R. **Hargreaves**: The quadratic form for radial acceleration, in the theory of relativity.—G. S. **Carter**: On the early development of the echinoderm egg. I—III.—D. **Keilin**: On the appearance of gas in the trachea of insects.—G. S. **Adair**: A comparison of the molecular weights of the proteins.—Miss I. A. **Hoggan**: The parasitism of *Plowrightia ribesia*.—R. C. **Woodward**: The overwintering of apple mildew *Podosphaera leucotricha*, in England.—K. G. **Emeleus**: The number of β-particles from radium-E. Using an electrical counter of the type devised by Geiger, the number of α- and β-particles from a source of radium-D, radium-E, and radium-F in equilibrium has been measured. After correction for reflection of β-particles at the source, their numbers were about equal. The β-rays from radium-D would not be recorded under the conditions of these experiments. On this assumption, the observed β-radiation was due to disintegration of radium-E, and since this was in equilibrium with the radium-F, it follows that about one β-particle is emitted per disintegrating atom of radium-E.

Official Publications Received.

Ministry of Public Works, Egypt: Physical Department. 1: Observations of Duration of Sunshine in Egypt and the Errors of an old Type of Recorder; 2: Anomalous Behaviour of the Silk Suspension of a Kew Magnetometer. By H. Knox-Shaw. 3: Corrections to Survey Department Paper No. 33—The Magnetic Survey of Egypt and the Sudan. (Physical Department Paper No. 15.) Pp. 15. (Cairo: Government Publications Office.) P.T.5.

Manchester Test of the Yadil Treatment of Tuberculosis in One Hundred Cases. Preliminary Report. By Alex. Clements. Pp. 28. (London: Quality Press, Ltd.)

Catalogue of India and Burma Forestry and Timber Exhibits in the India and Burma Pavilions; also in the H.M. Govt. Building, Lloyds Bank, Palace of Engineering, etc., British Empire Exhibition, Wembley, 1924. Pp. 139. (London: W. W. Howard Bros. and Co.)

Philosophical Transactions of the Royal Society of London. Series A, Vol. 24. A.620: The Principal Constituent of the Tides of the North Sea. By J. Proudman and A. T. Doodson. Pp. 185-219. (London: Harrison and Sons, Ltd.)

Leeds University. Nineteenth Report, 1922-23. Pp. 180. (Leeds.)

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia Jaarverslag, 1923. Pp. 28. (Weltevreden: Landsdrukkerij.)

Museums of the Brooklyn Institute of Arts and Sciences. Report upo the Condition and Progress of the Museums, for the Year endin December 31, 1923. By William Henry Fox. Pp. 60+3 plate (Brooklyn, N.Y.)

Ninty-ninth Annual Report of the Committee of the Bath Roy Literary and Scientific Institution for the Year 1923. Pp. 12. (Bath.)

The Physical Society of London. Proceedings. Vol. 36, Part 4, Jun 15. Pp. 241-340. (London: Fleetway Press, Ltd.) 6s. net.

Publications of the Kapteyn Astronomical Laboratory at Groninge No 32: On a Thermo-electric Method of measuring Photographi Magnitudes. By J. Schilt. Pp. ii+31. No. 35: The Proper Motions the Hyades derived from Plates taken at the Helsingfors Observator by Prof. A. Donner. Measured and discussed by Prof. Dr. J. Van Rhij and W. J. Klein Wassink. Pp. ii+19. (Groningen: Hoitsema Bros.)

Royal College of Surgeons of England. Annual Report on the Museu by the Conservator. Pp. 24. (London: Royal College of Surgeons.)

Proceedings of the Cambridge Philosophical Society. Vol. 22, Part Pp. 83-199. (Cambridge: At the University Press.) 5s. net.

Commonwealth of Australia: Institute of Science and Industr Second Annual Report of the Director for the Period from the 1st Jul 1922 to the 31st December 1923. Pp. 76. (Melbourne: Albert J. Mullett

Department of Agriculture, Ceylon. Bulletin No. 55: Improvemer of Yield in Hevea by the selection of Seed Bearers. By G. Bryce a C. H. Gadd. Pp. 42. Bulletin No. 68: Yield and Growth in Hev Brasiliensis. By G. Bryce and C. H. Gadd. Pp. 74. (Peradeniy 15 cents each.

Report of the Proceedings of the Fifth Entomological Meeting, held Pusa on the 5th to 10th February 1923. Edited by T. Bainbrid Fletcher. Pp. xiii+422+38 plates. (Calcutta: Government Printi Office.) 9.8 rupees.

Government of Madras. Annual Report of the Chemical Examine 1923. Pp. 13. (Madras.)

University of Illinois Engineering Experiment Station. Bullet No. 142: An Investigation of the Fatigue of Metals, Series of 19 A Report of the Investigation conducted by the Engineering Experime Station, University of Illinois, in Co-operation with the National Resear Council, the Engineering Foundation, the General Electric Company, t Allis-Chambers Manufacturing Company, the Copper and Brass Resear Association, the Western Electric Company. By Prof. H. F. Moore a Prof. T. M. Jasper. Pp. 88. (Urbana, Ill.: University of Illinoi 45 cents.

U.S. Department of Agriculture. Farmers' Bulletin No. 1407: T Mexican Bean Beetle in the East. By Neale F. Howard. Pp. Farmers' Bulletin No. 1408: The House Fly and How to Suppress By L. O. Howard. Pp. 18. (Washington: Government Printing Offic 5 cents each.

Proceedings of the Royal Society of Edinburgh: Session 1923-19 Vol. 44, Part 2, No. 12: A Static Model for Helium. By Dr. H. Stan Allen. Pp. 116-128. 1s. Vol. 44, Part 2, No. 13: The Cathode Fall Potential in a High Voltage Discharge. By G. P. Thomson. Pp. 129-1 1s. Vol. 44, Part 2, No. 14: The Electrolysis of Mixtures of Acetates a Trichloracetates. By Ralph Edward Gibson. Pp. 140-152. 1s. (Edinburgh: R Grant and Son; London: Williams and Norgate.)

Bulletin of the National Research Council. Vol. 8, Part 4, No. The Geological Implications of the Doctrine of Isostasy. By Andrew Lawson. Pp. 22. (Washington, D.C.: National Academy of Science 40 cents.

Department of Commerce: Bureau of Standards. Miscellane Publication No. 57: Large Mollier Chart (Foot-Pound-Fahrenheit Uni Properties of Ammonia. 48 in.×20 in. (Washington: Governm Printing Office.) 10 cents.

Proceedings of the Society for Psychical Research. Part 93, Vol. June. Pp. 285. (London: Francis Edwards.) 16s. net.

City and County of Kingston upon Hull: The Third Port of the Uni Kingdom. (British Empire Exhibition, Wembley, 1924: Hull Ci Fortnight, July 2nd to July 15th.) By T. Sheppard. Pp. 40+8 plat (Hull: Municipal Museums.)

Jahrbücher der Zentralanstalt für Meteorologie und Geodynam Amtliche Veroffentlichung. Jahrgang 1919. Neue Folge, Band Pp. xvi+A36+B35+C72. (Wien: Gerold und Komp.)

Diary of Societies.

TUESDAY, JULY 15.

INSTITUTE OF CHEMISTRY STUDENTS' ASSOCIATION (London) (at Univers College), at 9.45 A.M.—Inaugural Meeting.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

WEDNESDAY, JULY 16.

INSTITUTION OF CHEMICAL ENGINEERS (Annual Corporate Meeting) Hotel Cecil), at 11 A.M.—Sir Arthur Duckham: Presidential Addr —Sir F. Nathan: The Work of the Educational Committee on Training of a Chemical Engineer.—E. A. Alliott: Self-balanc Centrifugals.—G. W. Himus and Prof. J. W. Hinchley: Evaporat in Currents of Air.

FRIDAY, JULY 18.

ROYAL METEOROLOGICAL SOCIETY (Summer Meeting at the Rothams Experimental Station, Harpenden), at 2.15.—R. A. Fisher: Adaptat of Variety to Climate.—W. B. Haines: A Comparison of Three Differ Types of Radiation Recorders.—Dr. B. A. Keen: A Study of Gro Water Level Changes in Soil Cylinders.

SATURDAY, JULY 19.

PHYSICAL SOCIETY OF LONDON (Special Meeting at Cambridge), at 4.1 Sir J. J. Thomson: Radiations in a Discharge Tube.—Sir Er Rutherford and Dr. J. Chadwick: Recent Experiments on the Artif Disintegration of the Elements.—Dr. G. F. C. Searle: A Two-din sional Recording Accelerometer for Aeroplane Research.

NATURE

SATURDAY, JULY 19, 1924.

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2855, VOL. 114]

Lord Kelvin.[1]

THE hundredth anniversary of the birth of William Thomson, Baron Kelvin of Largs, was commemorated in Glasgow and elsewhere on June 25. Although Glasgow was the scene of Lord Kelvin's life-work, he was actually born in Belfast, where his father, James Thomson, was professor of mathematics at the Royal Academical Institution. The city of Belfast is, indeed, very proud of its association with the illustrious physicist, and an impressive statue of Lord Kelvin adorns its Botanic Garden, adjoining the Queen's University.

William Thomson was eight years of age when his father became professor of mathematics at the University of Glasgow, and the family exchanged Belfast Lough for the Clyde. Letters are still preserved which show Thomson's love of navigation and its problems, and how he tackled some of them in his youth with the help of his brother James, afterwards professor of engineering in the University of Glasgow. He was always a sailor at heart, and his name is one of the very few names of physicists which are familiar to mariners throughout the world.

Lord Kelvin's connexion with the University of Glasgow, which began in 1832 and was only severed by his death on December 17, 1907, witnessed an extraordinary series of changes in the status of science in the world's universities. In Glasgow, as elsewhere at the beginning of his career, "Natural Philosophy," as Dr. David Murray says, "was purely an Arts subject and was regarded as an instrument for what Francis Bacon terms 'that improvement of the understanding which results from the cultivation of natural knowledge, and that elevation of mind which flows from the contemplation of the order of the universe,' and was on the same footing as Logic and Moral Philosophy; it was not treated as part of a scheme for the training of specialists. This was certainly Professor Thomson's view, who held that Greek, as an instrument of culture and mental discipline, was an essential part of the Arts course and that every scientific man should have a fair acquaintance with it."

Lord Kelvin never went to school. All his education up to the age of ten was given him by his father, along with his brothers and sisters. He used to say that he never met a better teacher in *anything* than his father was in *everything*. At a dinner of the University of Glasgow Club in London, Lord Kelvin once said that the average boy should be able by the age of twelve to write his own language with accuracy and some elegance.

[1] "William Thomson, Lord Kelvin, 1824–1907: an Oration delivered in the University of Glasgow at the Commemoration on June 25, 1924, of the Centenary of Lord Kelvin's birth," by Dr. Alexander Russell. Pp. 22. (Glasgow: MacLehose, Jackson and Co., 1924.) n.p. "Lord Kelvin as Professor in the Old College of Glasgow," by Dr. David Murray. Pp. iv+22+4 plates. (Glasgow: MacLehose, Jackson and Co., 1924.) n.p.

He should have a reading knowledge of French and German, and be able to translate Latin and easy Greek authors. He should then study logic, in order to apply his words sensibly.

Lord Kelvin matriculated in the University of Glasgow at the age of ten, and at fifteen he gained a University medal for an essay on the figure of the earth. He entered Peterhouse, Cambridge, at the age of seventeen, and in 1845 was declared second wrangler and in the following year Smith's Prizeman. In this year, at the early age of twenty-two, he was elected to the chair of natural philosophy at the University of Glasgow. "Those," he said, "were the palmy days of Natural Philosophy—the pre-commissional days." They were the days when lectures were preceded by prayer, when the professor would "meet his classes" for two hours on five days of the week for six months, and would devote the rest of the time to original research, in which chosen students might take part as assistants. *Lehrfreiheit* was a reality then, and the professor might teach whatever seemed to him best for forming the character and stimulating the imagination of the students. There was no thought of training for manual dexterity, inventiveness, or practical research. "Science" had not yet arisen as a faculty to be cultivated for its own sake or placed on an equality with the *artes humaniores*. Had the commercial value and utilisation of science been an object of university training in 1846, William Thomson would, in all probability, not have accepted the chair. Yet he himself was a shining example of the economic value of scientific knowledge and invention based upon it. He made innumerable inventions, and from some of them he derived considerable wealth, which the poverty of his early days enabled him fully to appreciate.

The sixteen years from 1850, when a steam tug laid the first submarine cable between Dover and Calais, to 1866, when the first permanent cable was laid between Europe and the United States, showed Lord Kelvin in a new light. He formulated and expounded the theory of cable transmission, and when he became a director of the Atlantic Telegraph Company, he did the work of the "drummer boy" in steering the company through the crises produced by the repeated failures of the cables. "What has been done," he said to the shareholders, "will be done again." The 1865 attempt was a failure, 1800 miles of cable being left at the bottom of the sea. But in the summer of 1866 not only was a new cable laid, but the old one was also recovered and completed.

While his work on cables gave Lord Kelvin his knighthood and the freedom of the city of Glasgow, it gave the electrical world the mirror galvanometer and the siphon recorder. These were followed by the electrostatic voltmeter and the electrodynamic balance. Lord Kelvin was a convinced advocate of the metric system, and his strenuous partisanship stimulated his colleague, Prof. Macquorn Rankine, to write his ballad "The Three-Foot Rule," which begins:

Some talk of millimetres, and some of kilogrammes,
And some of decilitres, to measure beer and drams;
But I'm a British workman, too old to go to school;
So by pounds I'll eat, and by quarts I'll drink, and I'll
work by my three-foot rule.

Lord Kelvin's laboratory, or "experimental room," as it was called, was an entirely new departure, and was the earliest physical laboratory in Great Britain. His manner of lecturing has been much admired and much criticised. Some say he was always above the heads of his students, and that he could not conceive their being subject to error. Sometimes he would let a student work out a problem of mathematical physics in the class, and would himself write down what the student dictated. After he had covered the whole blackboard on one occasion, the bewildered student said, "I am afraid, sir, I do not see where I am going." "Neither do I, Mr. Gillies; you may sit down," and the professor then sponged out all the ridiculous operations he had written down. He would, however, not tolerate facetious or irreverent answers, and would reprimand them severely.

On another occasion he despatched two students to the top of the College tower to take some observation with an electrometer. They reported the result, but it was of the opposite sign to what Lord Kelvin had expected. The professor was nonplussed, and advanced all sorts of theories to account for the result, only to reject them all as inadequate. Next morning he said he had spent the night trying to arrive at some explanation, but had not succeeded. On the third morning he appeared radiant. "Gentlemen, I have it now; they turned the instrument upside down." "It was the last thing that occurred to him," says Dr. Murray, "that a student in the Natural Philosophy class in the University of Glasgow could do so stupid a thing."

Kelvin has often been likened to Helmholtz, and for some time, indeed, the two had similar eminence and standing in their respective countries. Kelvin's almost universal genius left a lasting impression on his age. His estimate of the age of the earth has been vastly extended by the discovery of radioactivity, and his bold conception of the vortex atom is no longer regarded as corresponding in any way to reality, but he was one of the mightiest physicists who ever lived—"the foremost Cambridge man of science since Isaac Newton, and the most distinguished of the professors of the University of Glasgow."

Instinct and Culture in Human and Animal Societies.

Le Monde social des fourmis, comparé à celui de l'homme. By Auguste Forel. 5 vols. Pp. xiv + 192; iii + 184; vii + 227; vii + 172; vi + 174. (Librairie Kundig, Genève, 1921–23.) 10 Swiss francs each vol. A Summary by the author: "Mensch und Ameise." Pp. 70. (Rikola Verlag, Wien, 1922.)

MAN is an animal, albeit a social animal, and unless the study of man be made to rest on the firm foundations of biology, this study is doomed never to become a real science. The truth of this has been keenly felt by the early sociologists. In fact it has been almost an obsession with them, and the analogy between society and organism, taken literally and applied as a unique principle of research, has misled and wrecked most of the earlier attempts at systematic sociology. For in science, as everywhere else, work done by proxy, by borrowing or copying, does not lead very far. Though sociology should never break its contact with biological science, it must achieve its results by its own efforts, and recognise that the entirely different nature of its subject requires specific methods, poses new problems, and opens up new aims. The relations between human individuals in society can be compared to the intercellular process within the living organism only in a mystic, semi-poetical simile and not in any scientifically useful analogy. As a method of sociological research and exposition this simile is worse than useless, as has been proved by the unfailing sterility of the many attempts at developing such social systems.

Yet the fallacy is so firmly established, so alluring, that even a sociologist and field worker so exact and critical as the late Dr. Rivers, attempted in his last book ("Psychology and Politics," Kegan Paul, 1923) to give it currency once again. We read there, on p. 62, that the resemblance between the living organism and society "is something more than an analogy, and depends on the operation of some fundamental laws of development common to both organism and society." Again, the leading British anatomist and anthropologist, Sir Arthur Keith, approaching the problem from the biological point of view, writes in a passage, which, I confess, gave me a genuine pang of dismay, "the resemblance between the body physiological and the body political is more than an analogy: it is a reality" (The Rationalist Press Association Annual, 1924, p. 11). I fail to see why a *reality* should disguise itself as a *resemblance* and be perceptible only through an *analogy*. In any case, it is not superfluous to question the opinion of two such eminent thinkers and to give a demonstration, as I shall presently attempt to do, that there exists no analogy whatever between society and organism, in any scientifically useful sense of the word.

There are sociologists again who, abandoning the hopeless confusion between intercellular process and social relations, yet try to transfer certain theories from the evolution of life to that of societies. They regard anthropology and sociology as a science of social evolution and adapt such concepts as "struggle for existence," "natural selection," "adjustment to environment," to explain all facts of society. Apart from the recent, in the main very pertinent, criticism of exclusive evolutionism in anthropology (Pater W. Schmidt in Austria, Dr. Graebner in Germany, Dr. Rivers, Prof. Elliot Smith, and Mr. Perry in Great Britain) there is no doubt that the laws and principles of organic evolution do not hold good with relation to human societies, where the facts of organisation and culture introduce a new element and change the whole aspect of the process.

Recently we have witnessed another intrusion from biology into social science in the assertive and stimulating theory of the so-called herd instinct, which is supposed to be at the bottom of all social force and to explain all human institutions, laws, beliefs, fashions, and customs. This view, very popular among the amateur psychologists and sociologists of the day, will not bear a close sociological examination.

The question therefore remains: In what way should the sociologist establish his contact with biological science? In what exchange of services can the two studies derive mutual benefit? Where, on the other hand, must they draw the line of demarcation and recognise that the difference of their respective subject-matters precludes borrowing or encroachment? The answer to these questions cannot be hit upon *a priori* by a happy simile, inspired phrase, or armchair formula. It must come from careful comparative study of animal and human societies.

When therefore a pioneer biologist, and a student at first hand of human nature in several of its departments, summarises his life work on the social relations of ants, and does it with his attention directed to the comparative problems of human and animal sociology, this is an event of unusual importance for those who want to understand the biological foundations of society. The perusal of these five volumes, beautifully written and magnificently produced, with numerous plates, figures, and illustrations, fulfils the most exacting expectations of those who have learnt to admire Prof. Auguste Forel as a great entomologist, first-rate student of the human mind, and daring social reformer. It would be superfluous to recommend the work to the attention of the zoologist or biologist, and

no psychologist or philosopher will fail to find a mine of inspiration and suggestion in it. But its value for comparative sociology might perhaps not be so obvious, and it is on this point that it will be well to enlarge here.

The sociologist who, after his preliminary introduction (in vols. 1 and 2) to the ants, their anatomy, physiology, mentality, classification and distribution, follows up the fascinating description of their social life, will be at once impressed by the breach of continuity between the human and insect societies. Whereas in human groups, collective behaviour is co-ordinated by certain social forces, resting on *organisation* and supported by a scaffolding of *culture*, there is among the ants a complete absence of these two elements. Instead of this we find co-ordination by *instinct* and by *anatomical and physiological arrangement*.

If we compare the sociability of the ants with that of man, we find, as I have said, that the insects achieve their unity of action by instinctive arrangements which prompt each individual ant to respond to a specific stimulus in the same manner. Take, for example, their constructive activities. Prof. Forel gives a description of their natural implements, the specific bodily organs adapted in different species to different building aims. He describes the architecture of their nests, which, measured by the stature of the builders, would in certain cases dwarf the Pyramids by their size and crush sky-scrapers by their mass. When we follow the little insects at work, we find that the division of labour is rooted in the natural fact of polymorphism; that their tools and their tasks are prescribed to them by their anatomical structure; that any social organisation in the sense of hierarchy or compulsion is absent; that every insect is put in its place and works at its task, following an inner instinctive urge. Compare this with a group of men at work. Whether it be a savage community building a house or a canoe, or engaged in a hunting or fishing expedition, or whether we consider modern working men employed in some large industrial enterprise, we have a different picture. The division of labour is not based on fundamental anatomical differences, and the implements are not given by Nature but supplied by culture. The individual workers are not moved by instinct, but by the forces of social organisation which allows a small number of leaders to compel or lead or persuade the rest to work at a task in itself unpleasant. The anatomical equipment and instinctive endowment are supplanted by the gifts of material culture and the forces of social organisation.

If we study the family life of an ant-heap, and compare it with human marriage, family, and kinship organisation, we come to a similar conclusion. The biological chapter in the story of propagation is much longer and more complicated with the ants than with humans. By a natural division of functions, only a small part of the insect community is anatomically fit to mate and to produce offspring. With them the romance and tragedy of the nuptial flight and annihilation of the males, so vividly and fully described by Prof. Forel, is much more sharply defined by instinct and provided with greater variety of incidents than is the case with man. The further history of the progeny is still more complicated and requires practically in every species of ants a co-operation of one or more polymorphic forms which act as nurses, defenders, carriers, and feeders of the brood. Yet, in each phase of this very complicated process, we see that everything happens merely by the promptings of instinct, in satisfaction of a physiological need or natural craving specifically adapted to the process.

In the simplest forms of the most primitive human society, similar ends are brought about by entirely different means. While the anatomical and physiological difference is limited to the division of sexes, we see that the instinctive promptings to mate and take care of the progeny are in every one of their most elementary manifestations moulded, complicated, and co-ordinated by forces of tradition, organisation, and culture, of which we can perceive not even traces in the insect society. From the moment of birth, nay, from that of conception, the new human organism in the womb is the object of traditional observances: taboos, magical or religious rites, in higher societies hygienic rules and customary observances. The nursing, tending, and education of the child in human societies is also largely defined and consistently moulded by the tradition of the tribe; by its economic conditions, its legal system and its material culture. No doubt, both in sexual relations and in kinship bonds, the instinctive elements play a paramount rôle, yet in both they are invariably and powerfully modified by tradition. To this is due the fact that in no two savage tribes, in no two types of civilisation, do we find exactly the same sexual morals, marriage customs, or systems of kinship, while on the other hand we have to recognise that the underlying instincts and tendencies do not essentially differ throughout humanity.

M. Forel describes in detail the wars of ants, and with a certain zest of pessimism compares them with those of man. Here we see the same relation. As in love, so in hatred, the ants are moved by instinct and instinct alone. Every species, nay, every ant-heap, has its natural enemies—some stronger, some weaker, some belonging to the ant family, some to other animal domains. Against these the soldiers or workers will fight to death, using their natural anatomical weapons, moved one and all by the same hostile impulse, dropping naturally each into its place in the fighting-line.

How welcome would be such an army to one of those modern generals or politicians or journalists who seem to regard wholesale brutal destruction of life as the chief end of humanity! Yet human nature, bad as it is, and capable of unlimited depravation, is at least plastic, and it has to be fashioned into the negative evil, hostile attitude of hatred, even as it could be fashioned into an attitude of international tolerance, generosity, and desire for co-operation. Man has to manufacture the impulse of hatred, instinctively present in an ant-heap. In a savage tribe this is done by tradition, which, from generation to generation dictates to the tribesman who is his enemy and who is a friend. In our modern societies a shoddy mock-tradition of hatred is frequently manufactured in a week or so by the powerful, though despicable machinery of newspaper trusts, in which a leading mediocrity dictates to millions of others the basest and most negative feelings and impulses for destructive action. The weapons given by Nature to an ant-soldier, man had to create by means of civilisation —save the mark—and where in the insect army every soldier ant knows his place instinctively, man has to create his army organisation by ingeniously devised drill and subordination.

The chapters about the wars, predatory expeditions, and struggles of the insects in Prof. Forel's fourth and fifth volumes, read more excitingly than any imaginative novel or fantastic insect play. Some of the reflections of the author—notably in the small German booklet "Mensch und Ameise"—given with the vigour and enthusiasm of youth and with the wisdom and simplicity of age, afford admirable and inspiring reading.

We could similarly compare the economic activities of the ant-heap—their search for food, their "cattle," gardens, various arts and crafts—with those of man; or enlarge on the interesting problem of their means of mental communication and compare them with human language. The conclusion would be always the same. In human societies there exists a man-made system of material products, endowing the individual with the various implements, weapons, economic contrivances, each of which corresponds to some specific item in the anatomical equipment of the ants. Above all, there is the supreme human implement, language, which means thought and also community and continuity of thought. Language gives the possibility of tradition—that is, of the system of rules, ideals, moral precepts, laws, which mould, modify, and co-ordinate human instincts. In animal societies sociability is based directly on instinct: animals act in masses, for, having to live in masses, they are always moved by the same response to the same stimuli. Men act in groups because they are organised into societies—that is, their instincts have been shaped by tradition, a number of traditional motives has been inculcated into them, and they have been taught to use in co-operation the same apparatus of material culture, including language, the implement of thought. The animal, whether social or not, stands in immediate contact with the environment, its instincts being directly adapted to it. With man, culture stands between him and Nature as a secondary means of adaptation, and a secondary *milieu* at the same time.

This point of view will allow us to deal trenchantly with some of the fallacies enumerated at the outset: the society-organism simile, the herd instinct, and the wholesale borrowing by sociology of evolutional principles. Since the unity of the human group is brought about by the extremely complex process in which, through the co-operation of individuals and generations, tradition and culture and organisation are formed, sociology has to study this process, instead of comparing it to a thing so entirely different as a natural organic unity in which the cells of an organism are bound up. Again, since man, unlike the animal, does not stand in a direct immediate relation to environment, there is no use speaking about natural selection or struggle for existence, for these things do not apply to man, the only animal armoured by culture, tied with traditions, living in the artificial, secondary *milieu* of organised society.

Now, is there any specific herd instinct which would form the foundation of the sociability of an ant-heap? We have seen that life, in an insect community, follows several lines of typical, inherited behaviour, each associated with a special anatomical and physiological arrangement, each furnishing definite responses to specific features of the environment. Nutrition, propagation, search for food, various forms of aggression and defence, several types of symbiosis, all consist of a number of instincts each. But there is no special natural outfit, no physiological arrangement, not one single inherited tendency or response which would correspond to sheer sociality. Gregariousness is the general aspect of all their instincts, but certainly not one specific instinct. Prof. Forel does not show us anything or speak of anything even approaching herd instinct, nor can anything of the sort be detected by the most careful reader. If we have to discard this figment with reference to the most gregarious of animal societies, there can be still less room for it in the communities of man. "Human gregariousness" is even more removed from instinct than that of animals, and it consists essentially of the manner in which the various human instincts are moulded and co-ordinated by material culture and tradition, so as to result in the various mental uniformities which underlie organised behaviour.

We see, therefore, that even a brief summary of Prof. Forel's thorough and valuable results has enlightened us on the question of the biological foundations of society. We have seen that the distinctive features of human society are *organisation and culture*, the man-made, artificially created cohesion, and the man-made environment and equipment of the individual. Yet neither organisation nor culture is built up on the quicksand of human whim or creature imagination or contract or free will or historical accident or however we might call the "indeterminate mental." They are built on the foundations of instinct and in this the study of society stands in close relation to biology. But human instinct, unlike that of animals, is essentially plastic, and herein lies the possibility of culture. In studying how the plastic human instincts are modified in society, we learn to understand the nature of material culture, language, and tradition—the sum-total of civilisation. The further we push the study of the relation between instinct and culture, of the transformation of instinctive impulse into the social forces of beliefs, ideals, moral norms, and social sentiments, the better we learn to understand the enormous benefit derived by the sociologist from a comparative study of animal and human communities and the importance to him of a right understanding of the biological foundations of human character.

B. MALINOWSKI.

Oyster Mortality.

Ministry of Agriculture and Fisheries. Fishery Investigations. Series 2, Vol. 6, No. 3, 1923. An Account of Investigations into the Cause or Causes of the unusual Mortality among Oysters in English Oyster Beds during 1920 and 1921. Part I.: Report. By Dr. J. H. Orton (assisted in Laboratory Work by Miss Edith Worsnop. Pp. 199 + 12 plates. (London: H.M. Stationery Office, 1924.) 15*s.* net.

IN September 1920 there was a scare about the heavy mortality amongst the oysters on the layings of the Thames Estuary. This scare passed to Colchester, and to every part of the East Coast, and similar death-rates were also mentioned from the south and west. The matter was investigated by the Development Commission's Advisory Committee on Fishery Research, but so far as we can see from the Report before us, no accurate estimations were made of the deaths, either beforehand, or afterwards when it certainly would not have been too late; the Table given shows that unusual mortality was reported in the summer of 1921 in the Thames Estuary, and the only possible excuses for the lack of accurate investigation then are either that reports were not sent in at the time, or that the Development Commission refused to provide the funds for such. Oyster planters estimated the deaths in 1920 at 10 to 60 per cent. against an average of 10 to 15 per cent., but there is no indication upon what these estimates were based. As Holt in Ireland records losses from all causes of 39·6 and 54·6 per cent. on accurate figures, and Bulstrode showed that an English planter laid 241 millions in 13-years, and only picked up and sold 105 millions, we may be allowed to doubt the accuracy of the belief in this greatly increased and "abnormal" mortality, especially as no information is supplied as to deaths and the working of the layings in 1918 and 1919.

The Development Commission got to work with commendable rapidity. Drs. Orton, Brady, and Eyre, biologist, chemist, and bacteriologist, were engaged to investigate, and the first part of their Report is now published under Dr. Orton's name. The industry suggested poisoning by T.N.T. (tri-nitro-toluene), or some other poison, dumped into the sea, and the researches now described were mostly made to test this view. The examinations, analyses, and tank and other experiments were well conceived and done with the greatest care, but at the date on which the investigations commenced (Oct. 28) the mortality as indicated by hockley (hollow-sounding) oysters is stated to have been over. The work shows that it is "unreasonable" to suppose that the deaths can have been due to T.N.T. Various metals, nitrites, salts of picric acid and oil were considered one by one and eliminated. Indeed, the theory of poisoning would seem to have been almost definitely disproved, but we think that this disproof would have been stronger if there had been more investigation into the direction of the currents from the dumping areas, and if systematic inquiry had been undertaken into the mortality of other animals, especially near the dumps as laid down by the Advisory Committee on Fishery Research in their original resolution. Are there any records of heavy deaths among the slipper limpets or other molluscs, either on the oyster layings or elsewhere?

Coming to natural conditions, such as might be caused by fluctuations in weather, a comparison is made between 1912 and 1919 as two similar years, but no unusual mortality is recorded or recollected for 1912. The figures for layings and sales must surely be in the books of the chief oyster planters for the last twenty years, and would be interesting in this connexion; their publication could be of no harm from a trade point of view, as planters generally are sold out before the end of the season. The way the grounds are worked (cleaned up by dredging, harrowed, etc.) year by year would also require to be known, but the com-

plications introduced by that horrible American pest, the slipper limpet, would make figures of costs of little value. There were clearly large numbers of sea urchins and starfishes as well on the beds at Whitstable, but these are regarded as evidence of the healthy conditions of the beds, and the relative number of these most destructive animals in 1920 as compared with other years is not estimated; if 1919 was a year of poor shell growth, so far as thickness was concerned, either form might have caused a great rise in mortality in 1920. Dr. Orton especially asks for experiments as to temperature and salinity designed to cover yearly fluctuations.

The full results obtained by Dr. Eyre relating to oyster bacteria are deferred to Part II. of the Report, but interesting experiments with the filamentar Cladothrix are recorded. Weak oysters were found by Dr. Orton to have, as an almost constant symptom, peculiar muscle spindles, derived from the adductor muscle holding the shells together, individual spindles varying from 3μ to 90μ in length; they were also produced experimentally. This investigation and those on the crystalline style and on "bleeding" are largely new and will require to be read by every zoologist, to whom they will form the most valuable part of the researches.

The Report concludes by assigning no cause for the oyster mortality in 1920, the abnormality of which, as compared both with other years and the known conditions of certain of the grounds in 1919, the writer regards as unproven; in Part II. of the Report this matter should be considered. Some estimate of the months of greatest incidence of the mortality could easily have been made by the examination of the dead shells dredged up, and any correlation with the spawning season settled, this being a period of much death. We do not know enough about the food of oysters to make possible any consideration of the partial failure of their food supply at this season, this being in the writer's opinion the chief cause of death at Helford, provided that the layings are clean.

On the whole we consider that we are justified in calling this research a "panic study," and it would seem that it was really so as it was preceded by no accurate observations such as could have been made in three days off the Colne and at Whitstable. It was directly taken charge of by the Development Commissioners, and on the face of it the story as to T.N.T. and other poisons, comparing quantities dumped with the amount of water and its circulation, was a foolish scare. As an industrial matter it had to be undertaken in a special form, and certainly the excellent quality of the work put into it makes it scientifically valuable. All readers will be in agreement with Dr. Orton that we know far too little about the oyster, and that a good means of procuring knowledge would be that somebody "should found a Scholarship for Research on Oysters of a value of at least 300*l.* per annum" under suitable conditions, a suggestion that we would at once commend to the Development Commissioners. J. STANLEY GARDINER.

Three-Dimensional Geometry.

Principles of Geometry. By Prof. H. F. Baker. Vol. 3: Solid Geometry, Quadrics, Cubic Curves in Space, Cubic Surfaces. Pp. xix+228. (Cambridge: At the University Press, 1923.) 15*s.* net.

IT is an undoubted fact that greater intellectual satisfaction is to be obtained from the proof of a geometrical theorem by the methods of pure geometry than from an algebraical investigation of the same theorem, and treatises on the methods of projective geometry are not uncommon, even in English. But apparently the application of such methods to the study of three-dimensional problems is considered difficult, for English text-books either confine themselves to plane geometry or else devote a chapter at the end to a meagre account of quadrics. As for investigating by this means the properties of a space cubic curve or a cubic surface, that is never dreamt of. Salmon's "Geometry of Three Dimensions" is, we believe, the only English book which gives at all a complete account of the cubic surface, and in Salmon, of course, the algebraical side preponderates. Prof. Baker's third volume fills, then, an undoubted gap. To get into 223 pages an account of quadrics, of the space cubic and of the cubic surface, has involved a great amount of compression which is perhaps to be regretted; the book makes difficult reading, but the matter is there, and whoever will take the trouble to study its pages with care will be amply rewarded.

The method of treatment follows on the lines laid down in the previous volumes, the second of which was noticed in our issue of September 22, 1923, p. 428, though naturally less emphasis is put upon the logical point of view and algebra is used more freely in illustration of and supplementary to the geometrical work.

The first two chapters, parallel to chaps. i. and ii. of vol. 2, deal with the quadric surface defined by means of its generators and with its relations to a fixed conic, the properties of spheres, of circular sections, and of confocal quadrics coming in in their natural place. The elements of the theory of the linear complex and of the tetrahedral complex are touched upon by the way. Chap. iii. treats of the space cubic curve, arising as the further intersection of two quadrics with a common generator, or obtained as the locus of intersection of corresponding planes of three related axial pencils.

A series of examples gives in summary form many properties of the curve and its construction to satisfy various sets of conditions; for example, it is shown that two general space cubics have ten common chords and that there are six space cubics having six arbitrary lines as chords. The theory of self-polar tetrads and of self-conjugate pentads and hexads on the curve is also developed.

The final chapter is introductory to the theory of the general cubic surface, which it is intended to discuss later in connexion with a configuration in four dimensions. The well-known double-six theorem is first investigated and examples are considered of the figure of twenty-seven lines arising therefrom. A geometrical definition of the cubic surface is then given, and it is shown that there are families of space cubics lying upon it. This leads to the representation of the surface upon a plane. Other matters which are summarised in this chapter are the reduction of the equation of the cubic surface to the sum of six or five cubes, the bitangents of a plane quartic curve, the Hessian surface of a cubic surface, the four-nodal cubic surface and its dual, the Steiner quartic surface.

This book, it is safe to prophesy, will become one of the most treasured possessions of the student of geometry. F. P. W.

Our Bookshelf.

The Flora of the Malay Peninsula. By Henry N. Ridley. (Published under the Authority of the Government of the Straits Settlements and Federated Malay States.) Vol. 2: Gamopetalæ. Pp. vi+672. Vol. 3: Apetalæ. Pp. vi+406. (London: L. Reeve and Co., Ltd., 1924.) 42*s.* net each vol.

VOL. 1 of this series was noticed in NATURE of January 6, 1923, p. 6. Of Vols. 2 and 3 which have now appeared, the former deals with the Gamopetalæ from Caprifoliaceæ to Labiatæ, and the latter with the Apetalæ from Nyctagineæ to Salicineæ. The arrangement of the natural families is that of the "Genera Plantarum" except that in the second volume the Plantagineæ are inserted after the Plumbagineæ, and the Cardiopteridæ after the Convolvulaceæ. In the third volume the Aristolochiaceæ and Nepenthaceæ are transposed, the Hernandiaceæ are separated from the Laurineæ and the Opiliaceæ are included. The Urticaceæ are, however, still retained as one general family.

It is easy and perhaps somewhat ungenerous to criticise a work of the size and importance of this first complete flora of the Malay Peninsula. Moreover, it is rare that such an expert in field work as is Mr. Ridley should be equally at home in the herbarium, but it is undoubtedly due to this uncommon combination of capabilities that we find many points which are apt to provide difficulties to less fortunately equipped workers. For example, the contrasting in certain of the keys of comparative values only renders them valueless to a worker who may be in possession of one of the species only. Again, the frequent use of the abbreviation *l.c.* entails considerable search for the orginal quotation, and in the majority of cases is not a saving of space. Had the measurements been given in parts of a metre instead of tenths of an inch the work would have been more in accordance with present-day standards.

The work generally is of the nature of the old-time flora intended purely for the systematist. There must be a mass of information available which might have been indicated briefly, as for example on the ecology of the plants cited, for the very short extracts of field notes quoted are but little help to a worker who has not an intimate knowledge of the country and its vegetation. For workers in Malaya an index to the vernacular names cited would have been of great help, for in that country, where Malay is the common language, the plant names are first learnt in that language, and such an index would introduce the work to a much wider circle.

The references to the new species leave much to be desired. In the second volume there are one hundred and five and in the third volume twenty new species and new names given. The differential diagnosis is confined to a wholly inadequate line or mention in the key, and where the affinity lies with an extra-Malayan plant it is left to an occasional footnote to give assistance. Further, and what is perhaps worse in scarcely any cases are specimens quoted, only collectors' names. The figures are well drawn by Mr Hutchinson, and it is to be regretted that they are so limited in number. It is a pity there are so many minor imperfections to detract from the value of a work of first-class importance executed by an author with such a unique experience.

Differential Equations in Applied Chemistry. By Prof Frank Lauren Hitchcock and Prof. Clark Shove Robinson. Pp. vi+110. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd. 1923.) 7*s.* 6*d.* net.

THE problem of providing a student of one of the experimental sciences with a broad basis of mathematical knowledge coupled with the special technical facility in the subject required for the development of his own field is no mean one. Especially does it become acute, now that increasing demands of the teachers of his principal subject establish an ever greater monopoly of his time during training. Hence partly, the reason why so many chemistry, physics biology, and engineering students return in later years to their mathematical masters for expert assistance but this is not the whole truth. Teachers of mathematics must equally share the blame.

A reorganisation of mathematical teaching along "functional" lines is clearly indicated, and until that is undertaken seriously so that the methods are consciously directed to, and arrive at a concrete end with a detailed application to real and not "mathematician's" problems, much of our present teaching must be futile. The attitude of many teachers to their subject is false and cramped. In the introduction to this otherwise excellent book, for example we are informed that the student (of chemistry) has two important needs in mathematical technique:

(1) How to integrate the differential equation.

(2) How to perform the calculations needed to obtain an answer correct within the practical requirements of the problem.

Now this would be excellent were it not for the fact that (2) *is* (1) in practice; it is the exception to encounter an equation that can be "integrated" in the sense that it belongs to one of the so-called "Standard Forms," and recourse must then generally be had to approximations, *i.e.* to (2). But it is just the processes included in (2) that receive the least attention, and it is exactly a discussion of the "Standard Forms" that usually delimits the scope of the knowledge of differential equations acquired by physical and chemical students. The reason is not far to seek. They owe their pedagogic prominence to the position given to them in the earliest books on "Differential Equations," and retained ever since. For certain branches of "functional" teaching in mathematics little would be lost by "scrapping" the lot.

The present little book is an heroic attempt to make the best of both worlds by restricting attention only to equations that are integrable and useful.

H. LEVY.

Smithsonian Miscellaneous Collections. Vol. 74, No. 1: *Smithsonian Mathematical Formulæ and Tables of Elliptic Functions.* Mathematical Formulæ prepared by Prof. Edwin P. Adams; Tables of Elliptic Functions prepared under the Direction of Sir George Greenhill by Col. R. L. Hippisley. (Publication 2672.) Pp. viii+314. (Washington: Smithsonian Institution.)

THIS volume contains, in addition to the series of formulas of many branches of applied mathematics prepared by Prof. E. P. Adams of Princeton, a table of the elliptic functions, with an illustrated discussion of their chief applications in geometry, dynamics, and electricity.

The table of the elliptic function was prepared and calculated by Col. R. L. Hippisley; it gives, in a form suitable for immediate application, the series of functions $A(r)$, $B(r)$, $C(r)$, $D(r)$, $E(r)$, $G(r)$, $F\phi$, for every degree r of the quadrant, and every degree θ of the modular angle, where $\sin\theta=\kappa$ the modulus. These had been calculated already for the British Association, and printed, but held up for want of money.

Here A, B, C, D are the theta functions of Jacobi, but normalised to zero degree, so that with $\frac{r}{90}=\frac{u}{K}$,

$$D(r)=\frac{\Theta u}{\Theta_0},\quad A(r)=\frac{Hu}{HK},\quad B(r)=A(90-r),\quad C(r)=D(90-r),$$

giving

$$\sqrt{\kappa'}\,\mathrm{sn}u=\frac{A(r)}{D(r)},\quad \mathrm{cn}u=\frac{B(r)}{D(r)},\quad \frac{\mathrm{dn}u}{\sqrt{\kappa'}}=\frac{C(r)}{D(r)}.$$

Also $\phi=\mathrm{am}u$ is the inverse function of $u=F\phi$ of Legendre; and his elliptic integral of the second kind $E\phi=\frac{rE}{90}+E(r)$, so that $E(r)=Zu$, or $\mathrm{zn}u$ of Jacobi.

Provided with these functions, the third elliptic integral Π can be expressed in a form that can be calculated numerically from the table, where the results are given to ten decimals.

Acoustics of Buildings: including Acoustics of Auditoriums and Sound-proofing of Rooms. By Prof. F. R. Watson. Pp. viii+155. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 15*s.* net.

THE acoustics of buildings is a subject which has always possessed importance, but with the increasing size of public buildings and the congestion of our urban populations, it has assumed much greater importance in recent decades. Though a good deal has been written on this subject, there are few books which present the problems to be solved in a lay form suitable for those not possessed of scientific attainments. Prof. Watson has succeeded in producing a volume which should prove of great value to architects concerned with the design or acoustic improvement of auditoriums, and has incorporated a number of his own researches. The volume is divided into three parts, a short introductory chapter on the principles of sound transmission scarcely deserving of a main separation, the acoustics of auditoriums, and the sound-proofing of buildings. In part 2, after explaining the behaviour of sound in a room, the nature and control of reverberation, the successful design of an auditorium and sound absorption are discussed, followed by a very interesting chapter on practical examples from existing buildings. Part 3 gives a number of experimental tests on materials by the author and others, followed by examples of sound-proofing rooms and buildings, and a special chapter on ventilation in reference to sound, while vibrations in buildings are shortly dealt with. The work is a successful attempt to bring the investigations of science to the aid of the artist and technician.

Practical Chemical Analysis of Blood: a Book designed as a Brief Survey of this Subject for Physicians and Laboratory Workers. By Prof. V. C. Myers. Second revised edition. Pp. 232. (London: Henry Kimpton, 1924.) 25*s.* net.

THE second edition of this book contains alterations and additions necessary to consider advances made in the subject during the last two years. An additional separate chapter gives the methods of blood analysis followed by Folin and Wu, and Benedict's new method of uric acid estimation is described. This edition also contains descriptions of the estimations of hæmoglobin, oxygen, calcium, inorganic phosphates, and acetone bodies, and a chapter on quantitative micro-methods of urine analysis. Numerous references to original articles, and appendices on colorimeters and standard solutions, perfect a valuable book on a subject of rapidly growing importance.

Nouvelles Vues Faraday-Maxwelliennes. Par Charles L.-R.-E. Mengès. Pp. v+94. (Paris: Gauthier-Villars et Cie., 1924.) 10 francs.

M. MENGÈS reprints and expands some papers which have appeared in the *Comptes rendus* of the Paris Academy of Sciences, chiefly on the electro-optics of moving systems. He finds the special theory of relativity self-inconsistent and proposes in some measure to revert to the older "classical" conceptions. Nothing but a detailed and complete discussion of his views would be worth undertaking; and since it is impossible to find space for this here, we offer no opinion concerning them.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Possible Explanation of the Behaviour of the Hydrogen Lines in Giant Stars.

WHILE the general behaviour of the absorption lines in stellar spectra has been well accounted for by thermodynamic theory, the Balmer series shows marked peculiarities. In spite of the very high resonance potential, these lines appear even in stars of class G, and their intensity is conspicuously affected by absolute magnitude—that is, by the density of the stellar atmosphere.

According to the elementary theory, the fraction of all the hydrogen atoms present which are in the two-quantum state (and hence ready to absorb the Balmer series) should be $f_2 = q_2 e^{-(\chi_1 - \chi_2)/kT}$, where k is Boltzmann's constant, $\chi_1 - \chi_2$ the resonance potential, and q_2 the weight of the two-quantum state[1]; and this fraction should be independent of the pressure. Introducing $\chi_1 - \chi_2 = 10{\cdot}16$ volts we find $f_2 = q_2 e^{-117000/T}$. For T = 5000° (roughly corresponding to the outer atmosphere of the sun), $f_2 = 6 \times 10^{-11} \cdot q_2$; for T = 3000° (rather high for the corresponding region in an M-star), $f_2 = 8 \times 10^{-18} \cdot q_2$; and even for T = 10,000°, $f_2 = 8 \times 10^{-6} \cdot q_2$.

For comparison, we may take λ4481 of Mg+, for which $\chi_1 - \chi_2 = 8{\cdot}85$, and $f_2 = 1{\cdot}2 \times 10^{-9} \cdot q_2$ if T = 5000°. Allowance for the fact that much of the magnesium in the sun is neutral may at most reduce f_2 to $10^{-10} \cdot q_2$ of all the Mg atoms present. Now λ4481 and H_α are the strongest lines absorbed by atoms in the corresponding states; yet the former is barely visible in the solar spectrum, and the latter is one of the strongest lines of all. This would demand an absurdly great abundance of hydrogen relative to magnesium (itself an abundant element) if the effective values of q_2 were comparable. Moreover, in giant stars, and especially in super-giants, such as α Orionis and the Cepheid variables, the Balmer lines are very much stronger than in dwarf stars of the same general spectral class, though the temperatures of the latter are higher.

It appears necessary, therefore, to assume that the effective value of q_2 for the two-quantum state of hydrogen is increased, in some special way, by a very large factor, which increases as the pressure diminishes.

A tentative explanation may be found in the fact that one of the two two-quantum states of hydrogen is metastable. The state called 2_2 by Bohr (or $2p$ in the ordinary series notation) can pass to the normal $1_1(1s)$ state by emission of the resonance line λ1216; but an atom in the $2_1(2s)$ state can (so far as we know) get out of it only by the absorption of radiation, or else by a collision of the second kind with another atom or an electron. A similar condition is found in helium, where the 1σ state (the lowest in the doublet system) is metastable. There is direct evidence[2] that a helium atom may remain in this state for an average life of the order of 10^{-3} sec. or more, as against about 10^{-8} sec. for an excited atom which can get rid of its energy by radiation. The 2δ state for Mg+, concerned in the absorption of λ4481, is of the latter type.

If it may be assumed that the number of hydrogen atoms in the $2s$ state in a star's atmosphere, and hence the effective value of q_2, is greatly increased when the life of the metastable state is long, the peculiar behaviour of the Balmer lines becomes explicable. The increase in the concentration of absorbing atoms accounts for the strength of the lines; while collisions, which get the atoms back to normal and diminish this concentration, will be more frequent in the denser atmospheres of dwarf stars.

The average interval between collisions, in a gas of pressure p mm. and temperature T° K, between an atom of molecular weight m and radius r cm. and atoms of molecular weight m' and radius r' is

$$\frac{2{\cdot}24 \times 10^{-24}}{p(r+r')^2} \sqrt{\frac{mm'T}{m+m'}}.$$

For excited hydrogen atoms (for which $r = 2 \times 10^{-8}$ cm., $m = 1$) moving in a gas of temperature 5000° and pressure 0·1 mm. (roughly the conditions in the sun's reversing layer) the collision-interval comes out $1{\cdot}8 \times 10^{-4}$ sec. if the "other atoms" are ordinary hydrogen ($m = 1$, $r = 5 \times 10^{-9}$), and 9×10^{-6} sec. if they are electrons ($m = 1/1850$, $r = 0$). In a giant star, where the pressure is probably from ten to a hundred times less, these intervals would be correspondingly increased. They are evidently quite of the right order of magnitude to be dominant in determining the mean effective life of a metastable state such as has been observed in helium, and without influence on ordinary states.

The influence here suggested will be important only for atoms in metastable states of high energy content, which are more likely to lose energy than to gain it, even in collisions with other excited atoms.

We might therefore expect to find it for the familiar lines of helium. Here $\chi_1 = 24{\cdot}5$ and $\chi_2 = 4{\cdot}7$ for the 1σ state, so that f_2 should be $10^{-10} \cdot q_2$ at 10,000° and $2 \times 10^{-7} \cdot q_2$ at 15,000° (which is probably near the temperature at which the helium lines reach their greatest intensity). For λ4481, at 10,000°, $f_2 = 2{\cdot}8 \times 10^{-5} \cdot q_2$. Here again the helium lines are stronger than might be expected from the probable abundance of the element (though the latter is hard to guess at). More definite evidence is found in super-giant stars like α Cygni, where the helium lines are present, though there is no trace of them in ordinary giants of Class A_2 or even A_0.

For the Pickering series of He+, $\chi_1 = 54{\cdot}2$, $\chi_2 = 3{\cdot}4$ and $f_2 = 6 \times 10^{-9} \cdot q_2$ even at 30,000°, so that the argument from abundance would appear to be applicable.

The red triplet of oxygen, λ7772-75, for which the excitation potential is almost the same as for the Balmer series, should be strengthened in giant stars and Cepheids, and would be interesting to observe.

The great concentration of atoms in metastable states, which is here postulated, would not be expected to occur in a gas in thermodynamic equilibrium. Such concentrations have, however, often been observed experimentally in vacuum tubes, which are of course very far from being in such equilibrium. Whether the departure from equilibrium in stellar atmospheres, which undoubtedly exists, would permit a sufficient concentration to explain the observed facts in the manner here suggested may prove a problem of interest to theoretical investigators.

An observational test appears, however, to be possible. The supposed concentration affects only the $2s$ state of hydrogen, and not the $2p$ state. Of the three components of Hα, $2s - 3p$ is at 6564·516 (I.A.), $2p - 3s$ at 6564·658, and $2p - 3d$ at 6564·720. In the laboratory, the components of longer wave-length are the stronger. In the stars, that of shortest wave-length should, on our hypothesis, greatly predominate.

There is no hope of resolution of this group in the

[1] Fowler and Milne, M.N., R.A.S., 83, 403, 1923.
[2] F. M. Kannenstine, *Ap. J.*, 55, 345, 1922.

stars, and measurement of the mean wave-length of the blend is greatly complicated by the effects of radial velocity, and of the "K term." The latter unfortunately indicates a shift in the opposite direction.

Even in the sun, radial velocity may greatly complicate the investigation. Could the $H\alpha$ line be observed double in the prominences—or show to appear single when a pair of separation 0·15 Å would certainly be resolved—the question might be settled.

K. T. COMPTON.
H. N. RUSSELL.

Princeton University,
June 21.

Leaf-mould.

IT must be a matter of common knowledge to persons interested in woodlands that some woods and copses have a more or less thick deposit of leaf-mould, whilst in others this covering is absent. It is not a question of the presence or absence of particular trees, *e.g.* oak or beech, and it often happens that within the limits of a single wood considerable differences exist, in respect of leaf-mould formation, in different parts of it.

I have noticed that its presence or absence is very commonly correlated with the character of the surface soil. Sand or gravel promotes, whilst heavy, and especially calcareous, soils seem to inhibit its formation. In a small wood that I have had under observation for a number of years the surface varies from chalk to heavy clay, with a good deal of intermediate calcareous loam. Leaf-mould never forms naturally in this wood, although the conditions would seem to be generally favourable. The trees are reasonably thick, consisting mainly of beech and some oak. The ground is well drained and dry for the most part, whilst in other spots it is damp and even boggy. There are large hollows where leaves collect, and from which the winds never move them, even in winter. But no real leaf-mould ever forms. The mass of dead leaves and twigs rot down and evaporate, so to speak, next year. This is to be attributed to bacterial action, and I believe that for the most part the result is due to the bacteria being able to carry on the disintegration process, mainly to carbon dioxide and water, in the presence of the available calcium carbonate of the surface soil. In another wood near by there are deposits of sand and gravel overlying the loams and chalk, and there the abundance of leaf-mould is very striking.

It occurred to me that the presence of the "acid" silicious top soil might be the decisive factor in the situation. Such an acid soil, by not neutralising the products of bacterial action, would conduce to the arrest of bacterial activity and so might provide in the first-named wood the requisite condition for leaf-mould formation which had, up to that time, been lacking. This hypothesis received confirmation. A covering of sandy gravel spread over the surface of one of the hollows was followed by the formation of an excellent leaf-mould, though this had not occurred in this hollow before, nor did it take place at all in those hollows adjacent to it which had not received a coat of gravel.

I do not suppose that the whole story of leaf-mould formation is contained in the foregoing, and it may well be that in other situations additional or other factors are concerned. Indeed it seems certain that soil drainage also influences the process, perhaps through its affecting conditions of suitable aeration. At any rate it happens that when pans of clay occur near the surface of a gravel or sandy soil in woods, with the result that the ground is water-logged for a part of the year—in such places one looks in vain for leaf-mould, though a black peaty deposit may occur in its place. These peaty deposits are very different from genuine leaf-mould, though both owe their origin to the disintegration of vegetable matter.

Leaf-mould, regarded from the point of view of the succession of organisms that are concerned in its production, and of the complex chemical changes therein involved, offers an attractive field for research. It is perhaps scarcely necessary to emphasise the fact that in addition to problems of more purely scientific interest, there are others connected with it which are of industrial importance as well. J. B. FARMER.

Imperial College of Science and Technology,
South Kensington, S.W.7.

The Theory of Hearing.

REFERRING to Prof. Scripture's letter in NATURE, June 28, the following observations on the vowel response of piano strings, which differ from those described, may be worth recording.

Using a small Broadwood upright piano with the lid open, and singing or speaking well into the instrument, I have found, (1) That a recognisable vowel response is given to *all* the English vowel sounds, though those to *i* (as in eat) and I (as in it) are relatively faint, owing to the poor response of the strings to frequencies of 2000 and more.

(2) That the response *is* given almost equally well, whether the vowels be intoned as prolonged or as relatively instantaneous sounds.

(3) That quite a good response is given to vowels sung "portamento" (with a variation of pitch of about an octave) or spoken as short sounds of varying laryngeal pitch. In some cases, especially in that of *u* (who), the "portamento" response is quite as good as that for the same vowel when intoned at constant pitch.

Experiment shows that a vibrating rubber strip "larynx," attached to a double resonator, will produce a constant vowel sound while the frequency of the larynx note is varied over an octave or more, by variation of the air pressure supplied to the larynx.

It seems reasonable to suppose that, in the production of a "portamento" vowel sound in the human mouth, the same thing applies—*i.e.* that the resonance frequencies of the vocal cavity remain substantially constant, though the frequency of the laryngeal puffs which evoke them is progressively changing. R. A. S. PAGET.

74 Strand, London, W.C.2.

IN reply to Prof. Scripture's letter in NATURE of June 28, I am not able to discuss the more recondite points he raises as to the nature of vowel sounds, or the mathematical formulæ by which alone, as he states, they can be subjected to analysis. I cannot, however, accept his statement that the undamped piano strings fail to respond to short spoken vowels. The facts can be tested in a moment by any one who has access to a piano. The fuller the tone of the instrument the clearer will be the response.

My own observation is that one gets a recognisable and distinguishable vowel however short the utterance, and that the quality of the resonated vowel is not noticeably changed by shortening or lengthening the vocalisation of the vowel sound; and further, that the characteristics of the vowels are as clearly distinguishable in the sharply uttered as in the sung vowel: ă, ā, i, oe, oo, all seem to come out fairly clearly and distinguishably. As Helmholtz says, the

ee is not so good. I believe this vowel contains high-pitched partials. The effect is improved by directing the voice rather more to the upper end of the sounding board so as to bring out these particular partials. The deduction that one would naturally draw from this simple experiment is that the vowels do contain musical partials, capable of being resonated so as to produce a combination of tones which is characteristic of the particular vowel employed. Of course the vowels may also contain other constituents which are incapable of being resonated, at all events by so imperfect a resonator as a piano.

The two fundamental points on which we are at issue appear to me to be these: (1) Are noises, as distinct from musical sounds, capable of being analysed by a series of resonators? (2) Are sounds of rapidly changing pitch capable of such analysis? In answering the first of these propositions in the negative, is not Prof. Scripture assuming that the limitations of analysis by Fourier's theorem and of analysis by resonators are the same? Fourier's theorem is by definition restricted to the case of recurring wave forms, *i.e.* (so far as concerns the present discussion) musical sounds, and to their analysis into fundamentals and harmonic partials. But is not this restriction imposed upon mathematicians by reason of the fact that the permutations and combinations possible when inharmonic partials are admitted are practically infinite, and consequently defy mathematical analysis? May not all sound waves be looked upon as being compounded of simple harmonic vibrations and consequently theoretically capable of analysis into their constituents? If it be admitted for the moment that the fibres of the basilar membrane with their associated fluid columns in the cochlea do actually form a complete series of resonators, any succession of pressure changes communicated to the fluid in the cochlea will set in harmonic vibration a certain number of transverse sectors of the membrane. If the components of the exciting wave are harmonic, the sectors of the membrane set in vibration will be narrow bands definitely spaced, and the result will be the sensation of a compound musical tone. If they are inharmonic the tendency will be for the different vibrating sectors to overlap so as to form vibrating *areas* with no distinguishable maximum point, and we should then have a sensation of noise of indefinite pitch.

With regard to the possibility of the resonance of inharmonic partials, inharmonic tones sounded simultaneously on a musical instrument are capable of being analysed by resonators. How then can it be maintained that inharmonic partials from a single source are not amenable to a similar analysis?

In the case of sounds of rapidly changing pitch, the completeness with which they can be analysed will depend partly on the relation of the rate of change of pitch to the periodicity of the vibrations, and partly on the degree of damping of the resonators. To speak of "damped" and "undamped" resonators, as Prof. Scripture does, seems to be rather a loose use of terms. There are no absolutely "damped" or "undamped" resonators (so far as sound is concerned). Resonators are of all degrees of damping. The cochlea is rather heavily damped, and consequently the location of resonant response in it may be changed much more rapidly than in the case of piano strings. (The silencing of piano strings when the "dampers" are down is not damping in this sense at all).

In Dr. Hartridge's pendulum experiment (NATURE, May 17, p. 713) the vibration period of the pendulums is much longer than that of sound waves. The alteration of the length of the driving pendulum must therefore be much slower than in the case of change of pitch of a musical sound if a "jangle" is to be avoided. But in Prof. Scripture's example of the Savart's wheel, or siren, which is being speeded up, if the speeding is done very rapidly the result is a disagreeable noise, which probably results from some such irregular jangle of vibrations in the cochlea as is seen in the pendulum experiment when the rate of vibration is altered too rapidly.

Still it must be conceded that the question of degree of damping and sharpness of resonance in the cochlea is the most difficult factor in the resonance hypothesis. It is far too complicated a problem to be discussed adequately in the limits of a short letter.

GEORGE WILKINSON.

Sheffield.

Specular Reflection of X-rays.

LORENZ has developed the approximate expression for the index of refraction of X-rays

$$\mu = 1 - \frac{ne^2}{2\pi m\nu^2},$$

where "n" is the number of electrons per unit volume and "e" and "m" refer to the charge and mass of the electron. This expression would indicate that at very small angles X-rays should be totally reflected by the refracting medium. The critical glancing angle is given by the formula

$$\sin\theta = \sqrt{2(1-\mu)}.$$

A. H. Compton in the June 1923 issue of the *Philosophical Magazine* shows that he finds this reflection and that it is truly total reflection. His work was done by the ionisation chamber method.

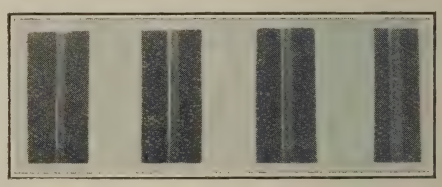

FIG. 1.

I have repeated his experiment by the photographic method, reflecting the general radiation of a molybdenum tube from crown glass. The arrangement of the apparatus differed somewhat from his. The radiation passed through a slit about 0·5 mm. wide and fell upon the surface of the glass, which was mounted on a spectrometer table. In order to obtain a sufficiently narrow beam of X-rays, the width of the beam was limited by mounting a piece of lead on the spectrometer table and pushing it as close to the glass as was necessary. The zero position of the glass was located by trial, it being taken as the position in which the primary beam was most intense. The photographic film and the slit were both 31 cm. from the centre of the glass. The angle through which the reflecting surface was rotated was measured on the spectrometer table. Angular separation on the film was twice the angle of rotation. The exposures for the reflected beam were ten minutes.

Reflection was obtained at the angles 6′, 8′, 10′, 12′. The intensity at the first three was approximately equal; at 12′ it was much less (Fig. 1). The reflected beam disappeared at 14′. These results are in accord with Compton's. The intensity of the reflected beam in this work, however, is not equal to that of the primary, being less than 20 per cent. as great. This

is probably due to the fact that the energy of the radiation from a molybdenum tube is largely concentrated in wave-lengths of about 0·4 and of about 0·7 Å.U., which have a very small critical angle. It was the longer wave-lengths, those in the region of 1 Å.U. and more, that were reflected at the angles of this experiment. This difference in intensity, therefore, is not contrary to Compton's results.

H. E. STAUSS.

Physics Laboratory, Washington University,
St. Louis, U.S.A., June 13.

Science and Labour.

IT was obviously impossible in the general article in NATURE of June 14, on the Science and Labour Conference held at Wembley last month, to devote more than a few lines to any speaker; but for this reason I have been asked by representatives of certain research associations to correct an impression which might be gathered from the summary of my remarks concerning those associations, for the initiation of which previous governments were responsible.

In justice to the scientific workers in those associations, I should be glad if I might be permitted to explain that my criticisms were levelled against the suggestion contained in the last published report of the Advisory Committee of the Privy Council on Scientific and Industrial Research, that unless more financial support were forthcoming from the manufacturers' associations, the Government could not continue them after the expiration of the original contractual period of five years.

To my mind this amounts to a confession of the failure of the *policy* of the Advisory Committee and of the failure of a great many industries to realise the importance of research. In the first place, if the policy was to succeed, the research associations should have been given a much longer period of support. Five years is a short time to devote to most important problems in research, and even when they are solved there is abundant evidence that it takes many more years for the solutions to be applied, through no fault of the research worker, and sometimes through no fault of the manufacturers.

If the idea of co-operative research for groups of manufacturers is dropped, then, however important and commercially valuable the research already done may be, the primary object has not been achieved, and in that sense the money devoted to that object has been lost. I believe, in common with the members of the Research Committee of the National Union of Scientific Workers, that research must be fostered, and the staffs who have devoted their past few years to industrial research must be protected and kept together, with or without the financial support of the manufacturers, for industry exists for the nation and not primarily for the manufacturers. I believe the policy was wrong initially and the machinery defective, but it would be disastrous if the knowledge and the experience gained by the competent research workers were not utilised for the country. A. G. CHURCH.

House of Commons.

Birds as a Geological Agent.

MR. MARTIN has directed attention in NATURE of July 5, p. 12, to the fact that birds may carry shellfish to heights considerably above sea-level, and I remember as a student being warned against a too ready assumption of elevation of the land relatively to the sea founded on the occurrence of remains of mollusca above high-water mark. But the operations of birds in the past history of the world were probably far more extensive. Their efficiency in the distribution of seeds and minute organisms over seas is now generally acknowledged, and of course we are indebted to birds for valuable deposits of guano.

It is possible, however, that they may have played an even more important part in the destruction of other forms of life. The evolution of highly predacious sea-birds in later Mesozoic times must have been fatal to many types which had been developed without provision for protection against such foes, and it seems possible that the cessation of so many groups at the close of the Cretaceous period may be attributed to this cause. The cephalopods whose careers then came to an end would appear to have passed much of their time at the surface of the sea, where they would be an easy prey. At the same time the eggs and young of many reptiles would also be exposed to attack. The chelonians may have survived because they buried their eggs, as they do still.

Prof. Bonney suggested that it was our ancestors, the small primitive mammals, that disposed of their reptile enemies in this way. It may have been, but I cannot help thinking that the Hesperornis and its comrades were better equipped for the task. The Archæopteryx and the pterodactyls were older and presumably less efficient denizens of the air.

J. W. EVANS.

Imperial College of Science and Technology,
S. Kensington, S.W.7, July 7.

The Atlantic Salmon in New Zealand.

AN event of importance in the history of the acclimatisation of Salmonidæ has just recently been noted in New Zealand. For nearly sixty years New Zealand and Australia have been endeavouring to acclimatise the Atlantic salmon. (It is of interest to note that the quinnat salmon from the Californian coast is now thoroughly established in the South Island of New Zealand; recently I have identified examples from the south of the North Island.)

Fisheries' inspectors and anglers have reported that for the last two or three years *Salmo salar* was to be taken in large numbers in Lake Te Anau in Otago; but no specimens had been seen by me until recently, when Wellington fishermen took an alleged quinnat salmon in Cook Strait. This fish was examined and found to agree in most essential respects, notably the disposition of the teeth, with descriptions of *Salmo salar*. The scales, however, were smaller than commonly found by European observers. An interesting question to be decided in the future is whether we have developed our own *Salmo salar novæ-zealandiæ*, or whether we have here a chance variety which readily adapts itself to the environment.

Cook Strait is equivalent in latitude to the Spanish coast or northern part of the Mediterranean. So far as is known to science, the specimen above noted is the first Atlantic salmon ever taken in the sea in the Southern Hemisphere.

WILLIAM J. PHILLIPPS.

Dominion Museum,
Wellington, N.Z.

The Isotope Effect in Line and Band Spectra.

IN a recent letter to NATURE (June 7, p. 820) the use of quotation marks around the word "theory" in the fourth paragraph conveys an impression which was not intended. In the original manuscript the word was underlined, meaning that it should be italicised; but apparently this was misunderstood, and quotation marks were used instead.

ROBERT S. MULLIKEN.

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Harvard University, Cambridge, Mass.

Mountain Sickness.

By Prof. JOSEPH BARCROFT, F.R.S.

SCIENTIFIC men, according to no less an authority than Longstaffe, were the pioneers of mountaineering. Its vogue as a sport followed. "During the latter part of the eighteenth century, that great period of awakening interest and research into physical science, mountain ascents were encouraged and performed only by scientific men. Such men, practical observers, and expecting to be severely affected by what we consider to be only moderate diminutions in atmospheric pressure, noted even the smallest abnormal symptoms in themselves. . . . On the other hand, during the last fifty years mountaineering has become a sport and is practised by a much larger and very different class, although it is true that many men of scientific attainments are to be found among the ranks of the modern mountaineer."

The question naturally arises: why did the ascent of mountains awaken such keen interest in the scientific men of bygone days? And it is followed by another, namely: what has been the fruit of their researches? Those were the days in which almost nothing was known about the causation of disease—in fact it is difficult to realise how little was known on this subject even so recently as falls within the memory of the still middle-aged. I cannot say what may be the limits of middle age, but I know many men born in the early 'seventies who would account themselves young rather than old, and yet if we look back to, say 1872, and ask ourselves what was then known about the causation of disease, the answer is instructive enough. Since that date the whole science of bacteriology has arisen and has enlightened us as to the cause of innumerable complaints, the micro-organisms of which are known, and by analogy as to a number of others attributable to a flora as yet undiscovered. Then there are all the diseases which are caused by trypanosomes and other parasites, the life histories of which have been worked out; the hosts which transport them have been recognised, and therefore the mechanism of their causation is understood. Or, again, consider such troubles as swollen joints, which scarcely rank among the epidemics, and yet in how many cases are they caused by micro-organisms which can be recognised. In 1872 all these things were unknown, and therefore a pathological condition which could be pinned down to an evident cause was a *rara avis* among diseases.

Such was mountain sickness: by ascending you could acquire it, and, what was perhaps more remarkable, by descending you could, within limits, throw it off. Such was the interest which, as I make out, it held for scientific men.

Mountain sickness is called in the Peruvian Andes "seroche," and the fact that it is given a definite name, which appears in medical cyclopædias, coupled with the natural scepticism of the scientific inquirer, leads to the question, "Is mountain sickness a definite medical entity?" The question is the more pertinent because its manifestations differ greatly in different individuals—differ in degree and in kind. Dr. Alfred C. Redfield, in a paper read to an American society, the manuscript of which he kindly sent me, has stated the claim of "seroche" to a place among human maladies so clearly that I can do no better than quote him. "So definite," he says, "is its symptomatology, so general is its occurrence in these not unpopulous regions, that it deserves some attention as a clinical entity. Its severity is sufficient to give it, in connexion with the mining industry, a certain economic importance. While a few men were met who had never felt it, and many who had suffered but mildly, a very large number are so greatly affected as to be completely incapacitated for several days. In at least one authentic instance the 'seroche' of a normal healthy individual has been terminated by death. Each case is an individual story and up to the present no one has been able to predict who will and who will not be affected. A description of cases of two degrees of severity will serve to picture the chief features of the disorder. Making the ascent by train,[1] one lightly touched by 'seroche' experiences his first symptoms at an altitude of 10,000 feet or more. Subjectively lassitude, then headache, usually frontal, growing in severity, and perhaps nausea, are felt. One feels cold, particularly in the extremities, the pulse quickens, respiration becomes deeper and more frequent, the face is pallid, lips and nails are cyanotic. On descending from the summit to Oroya (12,000 ft.), though a marked improvement is felt one finds himself reduced to a helpless condition of weakness which renders the least muscular effort irksome and productive of shortness of breath, dizziness and palpitation. The night's sleep is restless, and on waking one feels much as he does on venturing to his feet after recovering from an acute infection. In two or three days one's strength returns, the colour improves somewhat, and all but the more severe forms of exertion may be taken without distress. The majority are less fortunate than this. During the ascent, the symptoms are qualitatively the same, but frequently more severe, and nausea gives way to vomiting. The night's sleep fails to bring relief. Severe headache, gastro-intestinal instability, and weakness continue for several days; the body temperature may be supra-normal (102° F. in the rectum) and at times one is aware of palpitation. Cyanosis is marked. After three or four days in bed relief comes, and in a week normal activity may be resumed."

There is probably more unanimity now than at any other time as to the cause of "seroche," for there can be few, if any, men of science who do not attribute it to deficiency of oxygen. At an altitude of about 14,200 feet, the barometer stands at 457 mm., and the partial pressure of oxygen in the air cells of the human lung is just about half the normal—about 50-55 mm. instead of 100–110.

During the century and a half which have elapsed since the time when, according to Longstaffe, scientific men commenced to make observations upon mountain sickness, opinion as to the cause of the complaint has vacillated a good deal. Two theories have been serious competitors to that stated above, and they have come from very different sources: one was the invention of the distinguished physiologist, Mosso;

[1] Of the Central Railway of Peru. The train leaves Callao at the sea level about 6 A.M. and reaches the summit, 15,885 feet in altitude, near the station of Ticlio, about 3 P.M. the same afternoon.

the other was due to the entrance of the sportsman into mountaineering. Let me first discuss the latter of these two theories; it is that mountain sickness is due to a combination of fatigue, cold, bad feeding, and other discomforts incident to attempts by unfit or unathletic men to climb mountains which are beyond their physical powers.

I yield to none in my esteem of the "modern mountaineer," but, with all due respect, I would submit that he is the last person whose opinion on this subject is of value, and I have no difficulty in "stating my reasons in writing." It is of the nature of all sound scientific investigation that, in seeking out the cause of any phenomenon, only one variable should be altered at a time. Of the four variables, temperature, physical exertion, diet, and oxygen pressure, the Alpine rock climber alters all simultaneously and then pronounces to which the "seroche," if felt, is to be attributed. If you wish to see mountain sickness, do not study it among trained athletes in the Alps, whose very training makes them abnormal beings, who can only attain the rather moderate altitudes on European mountains by the performance of notable feats of physical prowess combined with exposure to extreme cold and long periods spent without a normal meal. If you wish to find out whether or no "seroche" is due to oxygen want, go to some place at which the alteration in oxygen pressure can be attained by all and sundry for a sufficient time to bring on the symptoms, but without the complications to which reference has been made. Of these localities, Pike's Peak in Colorado is good, but the best is undoubtedly that to which reference has already been made, namely, the Ticlio summit on the Central Railway of Peru.

There (year in, year out), on any of the six working days of the week, you may see a train full of passengers arrive; and if you see what I saw at Ticlio station, it will be two long coaches of the Pullman type with a head extended from each window, for, as Dr. Redfield truly says, "The majority are less fortunate . . . nausea gives way to vomiting." Here is a train load of persons, Indian, half-breed, Peruvian, European, who have been transported, if going east, from the sea level in eight or nine hours with no effort to themselves. They have had hot meals on the way, for the principal occupation of the inhabitants of the town of Matucana, at an altitude of 7700 feet, appears to be that of feeding the passengers on the train. They have not been subjected to cold; Ticlio itself is not above the snow line, though about the height of the summit of Mt. Blanc, and even if it were, the train (or at least the compartment in which I was) was heated by a stove. There, and not in the Alps, you see the clean experiment; but the truth is that you may see it without going so far afield. Many laboratories contain respiration chambers of one sort or another in which the partial pressure of oxygen may be reduced either by exhaustion, as at the Consumptive Hospital at Brompton, or in Prof. Dreyer's laboratory at Oxford, or by partial replacement of the oxygen by an indifferent gas, such as may be done in the chambers used by Dr. Haldane and by his workers in the Cambridge Physiological Laboratory. In this last-named structure it has been my unhappy fate to suffer the classical symptoms of "seroche." The pressure of oxygen was decreased from day to day till it fell to that which corresponded to an altitude of 18,000 feet. After sleeping (I use the word rather euphemistically) the night in that atmosphere, I arose to make the usual analysis of the air which was my first duty each morning. I was scarcely out of bed before vomiting set in, I suffered from an intense headache, and gas analysis was a matter of great difficulty; by an effort of concentration I could read the graduations on the gas burette, but all outside the very centre of the field of vision was a blur.

The theory of Mosso that "seroche" is due to acapnia, or insufficient carbonic acid dissolved in the tissues of the body, is not seriously now held.

Taking it, therefore, as settled that mountain sickness is due to oxygen want, the question arises, "Oxygen want of what?" And the answer is, "Of the brain."

Such evidence as is at our disposal goes to show that the brain wants but little oxygen; that little, however, it wants very badly indeed. Complete deprivation of oxygen would abolish consciousness in a matter of a few seconds. An appreciable inadequacy in the supply produces the symptoms which Dr. Redfield has enumerated. These symptoms are manifested by many organs in the body, but a careful scrutiny of them shows that they are essentially not the effects of want of oxygen on the organs themselves, but they are evidence of deficient oxygen supply to the centres in the medulla oblongata which govern the activities of these organs. Let me take a single example, that of palpitation of the heart. The effects of oxygen want on the vertebrate heart when isolated and kept beating outside the body are slowing and ultimate cessation of the beat, and a lengthening of the time which elapses between the auricular and the ventricular contractions. Yet the effect of insufficient oxygen on the heart beat in the human body is just the opposite. Dr. Somerville stated in an account of the doings of the 1922 Everest Expedition, at the Royal Society of Medicine, that on the day on which he approached 27,000 altitude his pulse was about 200 "all day" (this last phrase colloquially).

Such a phenomenon may be due to lack of vagus control over the heart, or it may be due to asphyxial nervous stimulation of the suprarenals through the sympathetic system or to direct sympathetic stimulation, or to all together, but it is not the direct effect of oxygen on the heart tissue. Yet this nervous quickening of the heart may have results which are far-reaching enough. The only observations of which I know on the circulation in a case in which the heart beat at 200 were made on a student in the Cambridge Laboratory who suffered from occasional attacks of paroxysmal tachycardia. The heart in these attacks became very inefficient, only driving about half the normal quantity of blood round the body, and almost none through the skin, which therefore became very cold. Such a condition on Everest would court frost-bite in circumstances when already it is difficult enough to cope with the cold. In this last connexion it is very interesting to note, in the experience of the Everest party, the breathing of oxygen at once brought a glow of warmth to the skin.

So it is with the other symptoms; the vomiting is no doubt the effect of oxygen want, not in the alimentary

canal but in the brain; the breathlessness also is a medullary effect, but it at least has a beneficent aspect, for the greater the quantity of air passed through the lungs (other things being equal) the higher the oxygen pressure in the air-cells, and therefore the less the tendency to mountain sickness.

We may conclude with a few sentences on the subject of acclimatisation. In an article in NATURE on the return of the Cerro de Pasco Expedition nearly two years ago (vol. 110, p. 152, July 29, 1922), I have already discussed acclimatisation in some detail. So far as the observers on that expedition could judge, the factors in acclimatisation were, as had been found by previous workers, of two categories, those which tended to increase the pressure of oxygen in the arterial blood, and those which tended to increase the quantity of oxygen which each cubic centimetre of blood carried at any specified pressure. In the latter category are (1) the increase in the number of corpuscles in each cubic centimetre of blood coupled with a corresponding increase in the hæmoglobin; (2) an increase in the affinity of the hæmoglobin for oxygen, which is probably caused by a greater alkalinity of the interior of the red corpuscle.

Among the factors which tend to increase the pressure of oxygen in the alveoli of the lung, and so of the arterial blood, is the increase in the volume of air passed through the lungs. Probably the peculiar size and shape of the chest of the native inhabitants of the Peruvian Andes tends in the same direction. A native whose height is sixty-one inches has a chest of about the same size as a European of seventy inches in stature. No account of the factors concerned in acclimatisation can be complete without reference to a possible one, namely, a more copious blood supply to the medulla. Stress has already been laid upon the fact that symptoms of mountain sickness are medullary, and more accurate knowledge is desirable of the factors which govern the blood supply of this part of the brain. Since our return from Peru, however, the work of Roberts has shown that the medullary blood supply is not simply the toy of circumstances, but is under the control of the brain itself.

Insects and Flowers.

By Dr. E. J. SALISBURY.

THE more definite relationships which subsist between organism and organism, whether it be between the algal and fungal partners of the lichen complex; between the forest tree, the orchid, or the gentian and their respective mycorrhiza; or between the Planarian worm *Convoluta Roscoffensis* and the alga Carteria, all alike bring home to one the delicacy of biotic relationships and the efficiency of whatever be the *modus operandi* of the evolutionary process. The relation between entomophilous flowers and the insects through the agency of which their pollination is effected constitutes no less remarkable an example of mutual specialisation than those already cited. It is scarcely surprising that the subject has attracted the attention of a considerable number of investigators from the observational period rendered notable by the publications of Koelreuter (1761), Delpino (1867), Mueller (1883), Darwin (1876), Kerner (1876), and Knuth (1898), to the experimental period of modern times initiated by the extensive researches of Plateau (1877–1910), and so ably followed by Lubbock (1882), Frisch (1913–19), Knoll (1919–22), and the work of Clements and Long, which has prompted and is the basis of the present article.[1]

The problems involved, though they admit of approach from either the botanical or the entomological point of view, can only be appreciated adequately if the interaction and interdependence of plant and animal be constantly before the investigator's mind. On the other hand, the earlier writers often obscured important issues by too teleological an attitude, as in the assumption that nectaries had been developed as organs of attraction for insects, whereas it is probable that, as the writer suggested fifteen years ago, all nectaries, both floral and extrafloral, originated as osmotic hydathodes and have secondarily acquired biological significance in relation to pollination. Occasionally extrafloral nectaries may themselves be important sources of honey supply, as has recently been noted for the partridge pea, *Cassia chamaecrista* (*Dixie Beekeeper*, 1922).

Every one recognises that insects, and especially bees, visit flowers for either honey or pollen, and that the process of pollination is incidental thereto. That this result ensues is the outcome of two factors, namely, the efficiency of the flower and the efficiency of the insect. With respect to floral structure, it is significant that, when closely related actinomorphic and zygomorphic types are compared, the latter are usually found to exhibit a reduction in the number of stamens and not infrequently in the ovary also; a reduction that could scarcely have come about without detriment to the race, but for the increased precision of the pollination mechanism which the zygomorphic form ensures.

It is, however, too often forgotten that pollen wastage would be enormous and insect agency almost as precarious as anemophily, were it not for the habit which bees in particular exhibit, of restricting their attentions, on a given flight, to a particular species of flower. Aristotle commented on this disposition, but the evidence respecting the degree of constancy seems to be somewhat conflicting, largely perhaps owing to lack of discrimination between the behaviour of the individual and the behaviour of the species. The observations of Clements and Long, for example, showed that the bumble bee, *Bombus juxtus*, visits at least twenty-seven species of flowers belonging to as many as twenty-two genera, and including such varied and specialised types of floral mechanism as Aconitum, Monarda, Thermopsis, and Gentiana. But when attention is confined to single individuals of this same species, the apparent fickleness of behaviour is seen to be illusory. This is sufficiently shown by the examinations of the pollen loads of twenty-five individuals of *Bombus juxtus* carried out by these investigators. Of these loads, nineteen consisted of one type of pollen only, whilst the remaining six were mixed pollen. Similar examinations of thirty-one honey-bees yielded

[1] "Experimental Pollination: an Outline of the Ecology of Flowers and Insects." By F. E. Clements and F. L. Long. Pp. vii.+274, with 17 Plates. Carnegie Institution, Washington. 4.00 dollars.

twenty-eight pure loads and three mixed loads. This high degree of constancy is not, however, always maintained with respect to the collection of nectar. The male bees, which in common with the Lepidoptera visit flowers mainly for nectar, may visit a variety of flowers even in a single flight, though constancy to one species is the general rule.

Numerous experiments in which flowers were placed in competition with one another as attractions to bees seem to show that these insects are remarkably constant to particular flowers, and that this is largely a matter of habit which tends to be perpetuated and developed owing to the increased dexterity resulting from practice. Mueller (1881) believed that the behaviour of bees indicated a psychological differentiation between the sexes, the males visiting the most accessible and fragrant flowers, whilst the thrifty females visit those which give the greatest yield of honey.

Admitting then the fact of constancy (oligotropism), it remains to inquire how the bee is attracted to the flower from a distance and on what features its taxonomic discrimination depends. The extensive experiments of Plateau, in which he employed artificial flowers of extreme perfection, showed that such are usually completely ignored, even though placed amongst their natural prototypes. The conclusion seems warranted that the perception of form and texture by bees is extremely acute. Experiments performed by Allard with the flowers of the cotton plant showed that Melissodes also has considerable discrimination with respect to structural detail. The story, recorded by F. P. Bedford, of the cabbage white butterfly which followed the artificial lilies of the valley on a lady's hat down a London street is scarcely less remarkable than that of the bee which flew to a coloured botanical wall-chart! The implied compliments in such occurrences are, however, more imaginary than real and bear testimony rather to the importance of colour and conspicuity as attractive devices than to the verisimilitude of the artifacts employed.

The experiments performed by Lubbock, in which he employed glass slips bearing honey and resting on variously coloured papers, indicated not only a preference of bees for blue, but also their colour-memory. Mueller and Lovell both obtained similar results, whilst the recent comprehensive study of Frisch (*Ver. Deut. Zoo. Ges.*, 1914), in which the range of colours was supplemented by numerous shades of grey, fully confirmed Lubbock's conclusion that bees recognise colour as such, and showed further that though distinguishing nuances of colour, there is a certain confusion similar to that of human beings colour blind to red and green.

Several investigators have shown that bees can be trained to visit a certain colour and exhibit association of impressions in a marked degree. Turner's experiments (1911) with diverse colour patterns demonstrated that amongst a mixed assemblage of these, bees usually return to the pattern to which they had become habituated. It is significant that the failures which have been experienced in the training of bees were associated with attempts to train for pure red and blue-green, unpleasant odours and geometrical patterns; that is, in respect to characteristics seldom if ever encountered by the bee under natural conditions.

It would seem to be fairly well established that colour and conspicuity are important agents of attraction up to a distance of ten metres, whilst the memory of a particular form and the less powerful odours, or their associations, serve as guides over smaller ranges of distance.

When several colour varieties of a given species are grown in proximity to one another, bees appear to visit them indifferently, which shows that form-association may predominate over colour-association. But the case of Pulmonaria shows that when colour differences are important, they are as much regarded as form. Bees visit the pink flowers of this plant freely, whereas when the corolla has turned blue, at which stage the flow of nectar has practically ceased, the flowers are neglected.

Clements and Long employed natural flowers of a variety of species, which they painted with water-colours and observed 420 visits to them as against 845 visits to the unpainted flowers. When artificial flowers were used, however, the number of visits was only about 12 per cent. of those to natural flowers, and in no case was a honey-bee deceived in this way. But, whilst this attests to the delicate perception of form, the frequent inspections made of the artificial flowers show that minute differences of structure are only detected at close range.

That vision plays an important part in influencing the flight of bees is shown by the tests on the so-called "homing" instinct. These experiments, and others using isolated plants and flowers, also show the pronounced place-memory which bees possess, despite which, however, their radius of action is usually short (about a mile from the hive).

Attraction for considerable distances may evidently be effected by strongly scented flowers, but our ignorance respecting such phenomena as the "assembling" of moths sufficiently indicates how much is still to be learnt regarding long-distance perception of stimuli. An increased number of visitors was noted by Clements and Long to flowers from which all the conspicuous parts had been removed, a result which was attributed to the greater accessibility of the nectar. In this connexion, one may recall that quite inconspicuous flowers with little or no scent but containing honey are freely visited. The odour of honey itself has been suggested as the effective agent of attraction in these cases, but the addition of honey to artificial flowers has little effect in increasing the number of visitors to them. On *a priori* grounds it would seem not unlikely that the range of light and scent perception in bees should be different from our own, but there appears to be little experimental evidence to support such a view. Various attempts have been made with mutilated insects to determine the seat of sense perception, but with regard to most of these, whatever view may be held as to the humanity of their conception, there can be little doubt as to their lack of scientific value.

There are but few observations and still fewer experiments which give any indication as to the importance of competition between flowers for the visits of insects. Robertson (1914) held that the flora is the limiting factor to the size of the bee population, whereas Lovell (1914) held that bees only collect a portion of the available pollen and nectar. The latter is probably the more correct view, and cases have been recorded

from gardens of species which are normally visited being entirely neglected for more attractive types. Upon the acuteness of this competition depends the importance to be attached to the sequence of flowering periods. Clements and Long, using the method of reciprocal bouquets, came to the conclusion that habit was the most important factor in determining preference, but that abundance of nectar or ease of access might overcome the effect of custom.

The marked capacity for memorisation by bees which training experiments reveal show that features of floral construction, of an apparently trivial character, may be of real importance in facilitating recognition. Moreover, the readiness with which bees discriminate the most profitable and easily worked flowers gives added significance to the minutiæ of floral architecture.

Further progress in the study of insect behaviour in relation to flowers would appear to demand the use of marked individuals of freshly hatched insects which have not acquired the habits that so largely determine their actions when adult.

X-ray Studies on the Crystal Structure of Iron and Steel.

AT the recent meeting of the Iron and Steel Institute Messrs. A. Westgren and G. Phragmen presented a continuation of work published by them two years ago at the same Institute. The present paper deals with the crystal structure of δ iron, the crystal shape of Cementite, and the structure of Austenite. In their previous paper a series of powder photograms of α, β, γ and δ forms of iron was reproduced. At that time all attempts to get a photogram of δ iron (stable only above 1400° C.) in the pure state had failed. Its interference lines were mingled with those originating from γ iron. By improved heating arrangements it has been possible to obtain a more uniform temperature, and the new photograms are quite free from γ interferences and confirm the conclusion previously drawn, namely, that δ iron has the same lattice structure as α and β iron.

The question as to how the atoms are grouped in Cementite (Fe_3C) has even now not been solved. The powder photogram contains a very large number of lines, some of which flow into one another. As many of the interferences of this orthorhombic substance practically coincide it could not be settled definitely, without a more thorough experimental investigation, to which of the net planes the lines of the powder photogram correspond. To decide this question so-called "complete photograms" or "rotation photograms" have been taken of a Cementite crystal obtained from the blow-hole of a spiegel melt. The only developed faces (001) were finely striated parallel to [010]. The precision camera designed for this purpose was described by the authors in NATURE of January 26, p. 122. The theory of the photograms obtained has been given by Schiebold and Polanyi. A special camera was constructed for establishing the lattice dimensions and the authors showed photograms thus obtained. The edges of the elementary parallelepiped are 4·518Å, 5·069Å, and 6·736Å. This corresponds with an axial ratio of 0·671 : 0·753 : 1. Laue photograms taken parallel with the three axes have given an axial ratio in perfect accordance with the above. If it is assumed that the elementary parallelepiped contains four molecules of Fe_3C the density of Cementite must be 7·68. Values hitherto available range from 7·74 obtained by Benedicks to 7·59 by Levin and Dornhecker.

The discrepancy which has hitherto existed with regard to the crystal structure of Cohenite—the iron carbide present in meteorites—has been cleared up. Weinschenk, who first investigated this mineral, found that its composition corresponds to Fe_3C, but concluded that it probably belonged to the regular system. Goniometric measurements were afterwards carried out by Hussak on a Cohenite crystal obtained from a Brazilian meteorite. In spite of the small size of the crystal, the fact that its faces were frequently curved, and that most of them gave very poor reflections, Hussak concluded that Cohenite belonged to the regular holohedral system. Even so, some of his angles differed 2° or more from the values characteristic of the cubic crystal. The authors show powder photograms of cementite and Cohenite which are practically identical. These two substances are therefore orthorhombic.

The authors have also used their precision camera to investigate the structure of Austenites obtained in various ways, both pure and intermixed with Martensite. They conclude that carbon dissolved in γ iron has an enlarging influence on the lattice dimensions, and that the lattice parameter changes from 3·606Å in the case of Austenite containing 0·9 per cent. of carbon, to 3·629Å in the case of the saturated solution containing 1·7 per cent. The Martensite lines, however, are too cloudy and broad to enable conclusions to be drawn concerning the lattice dimensions of the α iron in quenched steels. The authors reason that if carbon atoms replace iron atoms in the γ iron lattice the dimensions should decrease with rising carbon content, since the carbon atoms are much smaller than those of iron. Since, however, the opposite is the case, it seems probable that Austenite is not formed by simple substitution, but represents an addition product with the carbon atoms in the interstices between the metal atoms.

Precision photograms of a manganese Austenitic steel, having a lattice parameter of 3·624Å, show that in all probability this is the case. The density of the steel can be calculated either on the assumption that the iron and carbon atoms replace each other in one and the same lattice, or that the mass of the carbon atoms is uniformly distributed among the metal atoms which occupy the points of the face-centred cubic lattice. In the former case the density is 7·36, in the latter 7·83. The experimental value found was 7·83. The second assumption therefore is correct, and this Austenite is not formed by simple substitution but is an addition product. The real nature of the addition of carbon atoms cannot be decided on the basis of the results so far obtained. The authors suggest that it may be a substitution of the atoms of the γ iron lattice by complexes consisting of an iron atom combined with one or more carbon atoms.

H. C. H. C.

Obituary.

SIR JETHRO TEALL, F.R.S.

BY the death on July 2 of Jethro Justinian Harris Teall, one of the most noted and revered of living geologists has been lost to science. Accomplished in all branches of geology, he gained a world-wide reputation more especially as a pioneer in petrography, at a time when the study of igneous and metamorphic rocks was as yet in its infancy. Born on January 5, 1849, he was the son of Jethro Teall by his marriage with Mary, daughter of Justinian Hathaway, of Gloucestershire. On leaving school he went to St. John's College, Cambridge, and by so doing contributed to the development of the noted school of geology which was then coming into existence under Bonney's auspices. He was bracketed second in the first class of the Natural Science Tripos in 1872, and in 1874 was awarded the Sedgwick Prize for his researches on the Lower Greensand. He held a fellowship at his college from 1875 until 1879.

For a few years after taking his degree, Teall was engaged in delivering University Extension lectures, but his tastes lay rather in the direction of original research, more especially as regards the composition and origin of igneous rocks and the phenomena of metamorphism. In such studies British geologists had been outpaced by continental workers, but the balance was restored by the publication of Teall's "British Petrography," a book which was not only far in advance of its time, but was also a classic, and still remains a standard work of reference on the subject with which it deals. In the preface he alludes briefly to circumstances which threatened a tragic termination. "The work was commenced in February 1866, and completed in March 1888. One hundred and sixty-four pages and twenty plates were issued to subscribers in monthly parts. The issue then ceased, owing to the failure of the publishers, and I was compelled to take the work into my own hands in order to finish it." A discussion which took place between Teall and some of his friends in the Geological Survey, when the fate of the book lay in doubt, remains fresh in my memory. It was distasteful to press the author to dip so deeply into his own pocket as would be necessary to complete the publication, yet it was impossible to contemplate the abandoning of a work of such outstanding importance. In the end he faced the risk of loss, and I have reason to believe was eventually recouped by the sales what he had expended on publication. He had intended to include detailed petrographic descriptions of the sedimentary rocks and crystalline schists, but though some plates were included, he was unable to find space for the letterpress. Both kinds of rocks have since received much attention, but it is a matter for regret that they were not dealt with by the same master hand.

At this time it had become apparent that the whole-time services of a petrographer were required for the Geological Survey. Assistance in the identification of igneous rocks in the field required by the surveyors, and the technical descriptions of such rocks in the Memoirs, called for the services of an expert petrographer. At the same time, the care of the petrographical laboratory and the custody of the specimens collected in illustration of the field work, pointed to the necessity of that petrographer possessing businesslike habits. Sir Archibald Geikie, Director-General at the time, selected Teall for the post, as now standing in the first rank of British petrographers. The appointment was made on June 20, 1888, to the lasting benefit of the service. Though the nature of his duties necessitated attendance at the office for a large part of the year, the petrographer was able himself to take a small share in the surveying. Thus Teall was responsible for the mapping of the northern part of Raasay, an area occupied by schists and intrusive igneous rocks.

In 1901, on the retirement of Sir Archibald Geikie, Teall was appointed Director of the Geological Survey and of the Museum of Practical Geology. The institution had recently come under the consideration of a strong committee, the appointment of which had been strongly pressed for by the staff. The committee included representatives of various Government Departments and of scientific and mining interests. The recommendations made were sound and practical, and the task of giving them effect could not have been entrusted to more capable hands than those of the new Director. While the public service benefited, the time available for his own research work was unfortunately curtailed. But for his heavy administrative duties, we may suppose that "British Petrography" might have been completed on the lines originally contemplated. In 1914 Teall retired, leaving the institution as regards its work, organisation, and remuneration in a stronger position than it had ever before held. In 1901–5 he served as a member of the Royal Commission on Coal Supplies, representing geological interests with Mr. Lapworth as his colleague, until the latter resigned on account of ill health. He received a somewhat belated honour of knighthood in 1916.

Teall received honorary degrees from the Universities of Oxford, Dublin, and St. Andrews. He was elected a fellow of the Royal Society in 1890 and twice served on the Council, once as vice-president. In 1893 he was president of Section C (Geology) of the British Association, and in 1900–2 was president of the Geological Society of London. From that Society he received the Bigsby Medal in 1889, and its highest honour, the Wollaston Medal, in 1905. In 1907 he was awarded the Delesse Prize by the Paris Academy of Sciences. In presenting the Wollaston Medal, the president (Dr. Marr) addressed Teall in words which all who knew him will endorse. "You have ever placed your great store of knowledge at the disposal of other workers. How much work was thus due to you will never be known . . . but was it known, I can safely aver that it would be found to have promoted researches concerning the mineral structures of the Earth, to so great an extent as to render you doubly deserving of this medal."

A. STRAHAN.

SIR HARRY JAMES VEITCH.

FOR several decades past there has been no such outstanding figure in the horticultural world as Sir Harry Veitch, whose death on July 6, in his eighty-fifth year, we regret to record. His chief ability was his highly developed business faculty, for he could

lay no claim to scientific distinction, probably not even to a taste for science. Nevertheless, during a long and honourable career, he did more than any one to enrich our gardens with beautiful plants from foreign countries, and in that way helped on the cause of botanical science very considerably. Whilst his primary interest was to introduce to Great Britain plants valuable from the trader's point of view, he never grudged the time his collectors spent in making pure botanical collections of dried material. The collections made by his brother, John Gould Veitch, in Japan, consisting largely of cones of pines, firs, spruces, etc., helped greatly towards the elucidation of the coniferous flora of that country, just as, thirty years later, did the collections made by Wilson that of central and western China.

Sir Harry had that supreme endowment of the business man—the faculty of finding capable assistants—and in the long roll of collectors who worked for the firm, from William Lobb in 1840 to E. H. Wilson in 1900, there are included many famous names. Scarcely less noteworthy were the activities initiated by him in the hybridisation of plants. Under his direction, the first hybrid orchid was raised, *Calanthe Dominii*, the forerunner of a branch of horticulture that has grown to enormous dimensions at the present time. Very valuable work, too, was done in the improvement of hippeastrums, the East Indian group of rhododendrons, as well as in fruits and vegetables.

Sir Harry played a great part in the International Horticultural Exhibition of 1912, and his work for it was acknowledged by the bestowal of a knighthood on him. It is interesting to recall also that he was the last survivor of the managing committee of the previous International Exhibition of 1866. His career may be safely described as unique in horticulture in its length and activity. Two valuable standard works, the "Manual of Coniferæ" and the "Manual of Orchidaceous Plants," were published under his auspices, although the actual work was done by his assistant, A. W. Kent.

About ten years ago he retired from business and, having no one to succeed him, the Chelsea firm of Veitch came to an end, an event which can only be regarded as a calamity to British horticulture, for never had it stood higher in public estimation than during the days when gardeners, both amateur and professional, watched in sadness its famous collections of trees, shrubs, and hothouse plants being dispersed under the hammer. For the rest of his life, until within a few months of his death, Sir Harry worked actively in the interests of the Royal Horticultural Society, the astonishing success of which owes much to him, and in helping the many charities in which he was interested.

We regret to announce the following deaths:

Dr. R. Kidston, F.R.S., the distinguished palæobotanist, on July 13.

Prof. A. Marshall, emeritus professor of political economy, University of Cambridge, on July 13, aged eighty-one.

Sir Sydney Russell-Wells, member of Parliament for the University of London and vice-chancellor of the University 1919–22, on July 14, aged fifty-four.

Mr. Dean C. Worcester, first secretary of the Interior, Philippine Islands, who was largely responsible for the establishment of the Bureau of Science, the Philippine General Hospital and the College of Medicine in the islands, formerly assistant professor of zoology and curator of the museum at the University of Michigan, on May 2, aged fifty-seven.

Current Topics and Events.

Representatives of a number of educational, scientific, and commercial bodies in Great Britain and Overseas attended a conference organised by the Decimal Association at the Institution of Electrical Engineers on July 9. The main subjects discussed were the Association's proposal to divide the shilling into ten pence instead of twelve, and to alter the Imperial gallon so as to make it equal to four litres. The former proposal means a twenty per cent. increase of the value of a penny, and by it "an almost complete decimal coinage would be secured, while preserving the old names of *l. s. d.* and the three-column method of book-keeping, and incidentally a reasonable solution of the present impasse in penny postage and penny fares would be found." At present, services and commodities which could be profitably provided for slightly more than a penny are subjected to a fifty per cent. increase, whereas a penny would be sufficient if the value were increased as suggested. Mr. Harold Cox, who was a member of the Royal Commission on Decimal Coinage in 1920, said at the conference that if this proposal had been before the Commission he believed the majority of the members would have been in favour of it. The proposal to make the Imperial gallon equal to four litres instead of the present 4·54, so that the quart would become one litre and the pint half a litre, arises largely from the present confusion in the use of the designation "gallon" in commercial transactions relating to motor spirit and lubricating oils. The American gallon has a capacity twenty per cent. less than the Imperial gallon, and in South America a capacity of four litres is being called a gallon, so that a single name is being used for three different quantities. The introduction of a four-litre gallon would, of course, be an important step towards the adoption of other metric weights and measures in Great Britain. Whatever may be said in favour of the British system, it can never become an international system, and as trade develops with new countries the need for the use of a universal language of quantity by British firms must become more important every year. The conference passed resolutions urging the Government to appoint a committee to examine and report upon the proposals discussed.

In connexion with a recent paragraph concerning the therapeutic action of chlorine gas, it is of interest to observe an account in the *Sunday Express* of July 6 of the introduction as an antiseptic of a compound containing chlorine. There are two ways in which chlorine can be used therapeutically; in one method, a very dilute mixture of the gas in air is

haled; in this case the effect is confined to the spiratory tract; in the other method a solution ntaining chlorine in very dilute solution is applied rectly to the injured area as an antiseptic. It is t usual to utilise a solution of the gas itself, but me compound which is readily split up giving rise to evolution of chlorine. Solutions of hypochlorous id and hypochlorites were thus used during the ar in the method of continuous irrigation of wounds. he new substance referred to in the *Sunday Express* y Callimachi is trichlorophenylmethyliodosalicylic id. It will be observed that the basis of the compound is salicylic acid, which has itself antiseptic roperties, but is more frequently in use as an antiyretic. Combined with the chlorine group, it is robable that a compound actively germicidal may e obtained; the chlorine dissociated from it will imulate the tissues to pour out white blood cells nd lymph to destroy the bacteria, while at the same me the salicylic acid radicle itself will attack the tter directly. It may be remarked that the other dicles combined with the salicylic acid will probably hance the antiseptic value of the compound.

A RECEPTION was given at one of the conference alls of the British Empire Exhibition, Wembley, on uly 8, by the Italian delegation to the World Power onference, at which some films and slides were shown nd interesting particulars were given of Italian ower plants. Ing. G. Semenza introduced Sen. rince Ginori Conti, who gave an illustrated lecture n the production of power from natural steam, which, fter a certain amount of experimenting, is now used n a practical scale in various parts of the country. he steam issues from natural fissures, or bored wells, t pressures not exceeding 3 to 5 atmospheres, at emperatures up to 150° C. On account of this low ressure and the difficulty in condensing, owing to he presence of various gases mixed with it, the atural steam is not employed direct in the engines, ut is used to heat special boilers to produce pure team at a higher pressure. The largest plant of this ind, at Lardarello, contains three turbo-alternators, ach of 4000 H.P. Ing. Emirico Vismara then showed me films illustrating hydro-electric power development in Italy, which started in 1892 with the famous ivoli-Rome transmission, and in connexion with hich plants will shortly be complete aggregating bout a million kilowatts. Very high heads are available in the mountainous districts. The Moncenisio lant, for example, works under a head of 4200 ft., and mong the extensive schemes projected in the Trentino one for utilising a head of 6150 ft. Illustrations ere given of the combination of irrigation schemes ith electric power development and the manufacture f cyanamide artificial manures by the electric furnace. he linking up of the many water-power stations into ne vast national power network is in active progress. his will involve a connexion to Sicily across the traits of Messina, for which the relative merits of a ubmarine power cable, a tunnel, and an aerial line re being investigated. The last mentioned would equire the construction of two towers, each a thousand eet high and two miles apart, to allow for a sag of 900 ft. The films shown included some very beautiful examples of Italian scenery.

IN the year 1876 Lord Kelvin, then Sir William Thomson, took an active interest in the formation of the Loan Collection of Scientific Apparatus exhibited in the Western Galleries of the Science Museum, then part of the South Kensington Museum. He was a vice-president of the section "Physics," and at the Science Conferences held in the Western Galleries in May 1876 read two papers: "The Principles of Compass Correction" and "Electrical Measurement." Many of the original instruments of his invention which were lent by him for inclusion in the Loan Collection were allowed to remain permanently on exhibition in the Museum as gifts or loans, of great interest in the history of science. Since last autumn, when the Western Galleries were cleared to make room for the Imperial War Museum, most of these valuable objects have been stored away with 80 per cent. of the science collections previously exhibited in the Western Galleries. By utilising the main gangway of the unfinished gallery of the new Science Museum building in which, since last November, the remaining 20 per cent. of the collections have been exhibited, it has been possible to bring together these original Kelvin instruments so as to form a temporary exhibition of considerable interest in connexion with the Kelvin centenary. The following objects are included: Marine galvanometer used in the Atlantic cable expedition of 1858; iron-clad marine galvanometer used on board the *Great Eastern* in the Atlantic cable expedition of 1866; double curb transmitter; syphon recorder; various types of electrometer; original models of the tide-predicting machine; harmonic analyser for tidal computation; navigational sounding machine; binnacles; mariner's compasses.

A TEMPORARY exhibition of geophysical apparatus, etc., has been placed in the new building of the Science Museum, South Kensington, in the southern half of an unfinished gallery, the contents of which have been entirely rearranged. By arrangement between the Board of Education and the Royal Society Committee organising the Exhibition of Pure Science at the British Empire Exhibition, Wembley, it was intended that this exhibition should be placed in one of the new galleries of the Science Museum, but delayed progress towards the completion of these galleries has made it necessary to arrange the collection as above. It consists chiefly of objects selected from the permanent collections of the museum. To these have been added certain objects which, owing to the limited space available in the British Government Pavilion of the British Empire Exhibition at Wembley, cannot be shown there during the whole period of that Exhibition. The collection serves to give some idea of the history of the different sciences (meteorology, seismology, gravity, terrestrial magnetism, atmospheric electricity, geodesy) included under the general heading of geophysics, and to illustrate recent British contributions to these sciences.

ARRANGEMENTS have been made to establish at Oxford in October next the Imperial Forestry

Institute, which is intended to serve as an educational and research centre for the British Empire. It will be a University institution, with the professor of forestry as its director; but it will be under the control of a Board of Governors, with a Forestry Commissioner as chairman. The educational work of the Institute will comprise (1) post-graduate training of forest service probationers and other qualified persons, (2) training of research officers in special subjects, and (3) provision of courses for selected officers already serving. The Institute will be open to various categories of students, who must as a rule have had previous training at a university in forestry or some allied science. The normal course of study will extend over one academic year, and the subjects dealt with will cover the whole range of forestry. The main cost of the Institute will fall in the first instance on the Forestry Commission and the Colonial Governments; but it is hoped that the Dominion Governments and India will give some financial assistance. Temporary accommodation has been arranged; but larger buildings will be necessary, and the formidable task of obtaining funds for the purchase of a site and the building of the Institute remains.

SUDDEN changes of temperature were characteristic of the weather conditions which prevailed in England at the close of the second week of July. An anticyclone to the south-east of the British Islands had asserted itself and was temporarily controlling the prevailing weather. With a south and south-east wind blowing from the heated continent of Europe, high summer temperatures were experienced on Saturday, July 12, the thermometer in the shade registering 87° F. at Kensington Palace, the recording station of the Meteorological Office for London, a similar reading being registered at South Farnborough and Hunstanton, while at Nairn, in the north of Scotland, the temperature was 80°. This is the highest temperature as yet this year, although it is not uncommon for summer temperatures of 90° and above to occur occasionally in London; during the heat wave and thunderstorm in July last year the thermometer on July 11 and 13 registered 92° at Greenwich, and at the corresponding time in 1921 the shade reading was 94°, while in 1900, 1911, 1912, and 1914 the thermometer rose to 90° and above in July. The highest shade temperature on record at Greenwich is 100° on August 9, 1911. Owing to the spreading in of a cooler current of air from the Atlantic, which caused a temporary displacement of the anticyclone, there was a brisk fall of temperature on Sunday, the transition occasioning thunderstorms and heavy rains in places. The anticyclone surged to the north-westward again on Monday, July 14, and there was a return of the bright and hot weather.

A MEMORANDUM forecasting the probable amount of monsoon rainfall in 1924 was submitted in the early part of June to the Government of India by Sir Gilbert T. Walker, the Director-General of Observatories. The monsoon rainfall of India is affected by previous conditions over various parts of the earth. Snow in the mountain region north-west of India is an important feature; the accumulations at the end of May were markedly about normal from Afghanistan to Almora, especially at the higher elevations, and this excess of snow may be expected to retard appreciably the development of the monsoon. Among other factors are the rainfall percentages over Java; these were in defect during the period October to February, which indicates abundant monsoon rainfall in India. For the Peninsula, the indications from S. America, the Cape, Java, S. Rhodesia, Zanzibar, and the Aleutian Islands are this year all favourable. For north-west India most considerations are favourable. Summarising the effects, it is forecasted that there will probably be some delay in the establishment of the Arabian Sea monsoon, particularly in north-west India. In the rainfall of the Peninsula an excess may be expected. The indications for north-west India are said to be conflicting, but in spite of heavy snowfall the rains there are likely to be normal or in excess.

DR. R. F. RUTTAN, director of the Department of Chemistry, McGill University, has been appointed Dean of the Faculty of Graduate Studies and Research to succeed Dr. F. D. Adams, who has resigned from the University. Dr. Ruttan was president of the Royal Society of Canada in 1919 and of the British Society of Chemical Industry in 1922. He was appointed an original member of the Honorary Advisory Council for Scientific and Industrial Research for Canada in 1916. He represented the Dominion at Brussels in 1919 on the International Research Council and was a member of the committee which framed the constitution and statutes of the International Union of Pure and Applied Chemistry. Dr. Ruttan is an active and successful investigator, a good organiser, and has developed a very strong graduate school in chemistry at McGill. He is regarded as an excellent choice for the head of the Graduate Faculty.

W. C. ALLEE refers in *Science* (vol. 59, p. 521, 1924) to his recent two months' visit to Barro Colorado Island, the site of the new station for tropical research in Gatun Lake, Panama Canal Zone. The island was the largest of the old hills rising above the valley of the Chagres River and consequently is now the largest of the islands in the man-made Gatun Lake. Comfortable living quarters have just been erected and equipped so that a small party can live and work with comfort in the jungle, which is of the rain forest type and spreads over the five square miles of the island. Ants and termites are common and offer excellent opportunities for the study of habits and for the collecting of commensals; several new species of the latter have already been found. Peripatus occurs on the island. Birds, lizards, armadillos, peccaries, racoons, night monkeys, white-faced monkeys and black howling monkeys are common and relatively tame, and among other mammals found either on the island or near by are tapirs, sloths and ant-eaters. The station affords an opportunity for the study of the physical conditions under which animals live in this sort of jungle and has the great advantage of ready accessibility—being only two hours' journey from Panama City.

SIR WILLIAM POPE has been elected a foreign member of the Reale Accademia Nazionale dei Lincei of Rome, in the Section of Physics and Chemistry and their Applications.

THE autumn meeting of the Iron and Steel Institute will be held at the British Empire Exhibition, Wembley, on September 4-5. Applications to attend the meeting must be received at the Institute not later than August 15.

WE learn from *Science* that William Gaertner, president of the Gaertner Scientific Corporation, Chicago, has been awarded the Howard N. Potts Gold Medal by the Franklin Institute, "in consideration of his notable achievement as a designer and maker of scientific instruments, materially contributing to the success of the research in physical science."

APPLICATIONS are invited for an inspectorship of agriculture under the Sudan Government. Candidates for the post must have had a thorough practical and scientific training in agriculture and possess the national diploma or a university degree in agriculture. Particulars of the appointment are to be had from the Inspecting Engineer, Egyptian and Sudan Governments, Queen Anne's Chambers, Westminster, S.W.1.

THE Department of Scientific and Industrial Research invites applications for the post of superintendent of its chemical research laboratory. Candidates should have special knowledge of some branch of pure or applied chemistry. Particulars of the duties attaching to the post and a form of application can be obtained from the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1. Applications must reach the department not later than September 30.

THE International Commission on Illumination will hold its sixth session at Geneva from July 21-July 25. The session meets under the presidency of Dr. E. P. Hyde. Twenty-six papers on subjects connected with illumination are being presented, and delegates from America, France, Great Britain, Italy, Japan, Poland, and Switzerland will be present. The papers deal with photometric nomenclature, primary standards of light, heterochromatic photometry, automobile and industrial lighting, and legislation. It is expected that, as a result of the discussions, progress will be made on several problems in which international agreement and co-operation is desirable.

THE annual meeting of the British Medical Association opens with the meeting of the Representative Body on July 18, and on the evening of Tuesday, July 22, Mr. Basil Hall will deliver his presidential address at the Regent Picture House, Manningham Lane. Among the eminent foreign guests who will be present are Dr. Alexis Carrel of New York, Prof. Ignacio Barraquer of Barcelona, and Dr. Van den Bergh of Leyden. Before this address, the president will present the Stewart Prize to Prof. E. Mellanby, of the University of Sheffield, for his important discoveries on the relation between rickets and dietetic deficiency, and the Gold Medal of Merit of the Association (the highest award in the bestowal of the Association) to Dr. H. B. Brackenbury for his arduous and distinguished services to the Association and the medical profession.

THE summer conversazione of the Natural History Museum Staff Association was held on July 2, and was attended by a large number of members and visitors, many of the latter coming from overseas. The remarkable series of specimens which had been arranged by the desire of Dr. W. Bateson, a Trustee of the Museum, to illustrate the variation in characters in three zoological groups—birds, mammals, and molluscs—attracted much attention. Considerable interest was also taken in the selection exhibited from the collection mainly of vertebrate fossils made by the late Mr. R. W. Hooley in the Wealden of the Isle of Wight. This extensive collection has recently been acquired by the Trustees. Other notable exhibits included a new plant genus belonging to the family of Umbelliferæ and collected by the Misses Godman in Central Africa; and a few examples of the splendid photographs taken by Mr. M. Maxwell of the elephant and the rhinoceros.

THE Lecture Bureau of the Selborne Society has already issued its list of lectures for the 1924–25 season. The names of more than fifty lecturers appear in the list; the subjects offered number considerably more than three hundred, and thus afford a very wide field for selection by those desirous of engaging lecturers during the forthcoming season. The Bureau caters for all tastes: literature, art, scenery, folk-lore, commerce, psychology, and many of the branches of natural science are well represented on their list. We note, however, that while physical and biological subjects are named fairly frequently, there is an absence of those concerned with chemical processes. Considering how largely these enter into the industrial life of the present day, we venture to suggest that there are, up and down England, numerous audiences eager for clear information on such topics. Inquiries concerning these lectures should be addressed to the Secretary, Selborne Society, The Hermitage, Hanwell, W.7.

THE Rockefeller Foundation has issued a review of its activities during 1923, compiled by the president, Mr. George E. Vincent. A sum of more than eight million dollars was expended in forwarding public health and medical education in all parts of the world. The work included the support of 636 fellowships, international visits, emergency relief to institutions of 15 European countries, contributions to schools of hygiene, hookworm campaign in conjunction with 20 governments of the world, yellow fever campaign in Brazil, contributions for medical education in Great Britain and other countries, and malaria control in several countries.

IN a lecture given by Mr. T. Thorne Baker at the Royal Society of Arts on "Photography in Science, Industry, and Medicine" (R.S.A. Journal, June 23), which was illustrated by a very large number of examples, the lecturer said that "the plate chemist has learned the secret of the sensitiveness to light of

silver bromide, he can produce an emulsion in gelatin of this unique substance, which shall have a predetermined size of grain, of contrast-giving power and rapidity. He can make it sensitive to all the colours of the spectrum, to the invisible infra-red and ultra-violet rays, to the X-rays and shortest wave motions produced by radium." Mr. Thorne Baker explains that the sudden disappearance of pictures transmitted by telegraph was because the cost of transmission proved to be "altogether prohibitive." He hopes that before long a new system will be available on a really commercial scale—the time of transmission being reduced to 2½ minutes.

We have received No. 118 of Abderhalden's "Handbuch der biologischen Arbeitsmethoden" (Lieferung 118, Abt. 2, Physikalische Methoden, Heft 4. Die meteorologischen Messmethoden, von Walter Georgii; Die Makrophotographie, von Marie Kundt; Farbenphotographie, von Walter Thiem. Pp. 483-618. Berlin und Wien: Urban und Schwarzenberg, 1924. 6·40 Schw. frs.). It deals with meteorological measurements, such as temperature, pressure, moisture, wind-strength, etc.; macro-photography and colour photography. The matter is strictly practical, and not overburdened with a variety of methods or formulæ. In the photographic section, the support and manipulation of the camera and the support of subjects of various kinds are dealt with at length, as well as the numbering of series, as for indexing purposes, the copying of diagrams, engravings, and so on. The few pages on colour photography give just the extra assistance needed for the use of autochrome and "Agfa" colour plates by daylight and artificial light.

Mr. F. S. Spiers, secretary and editor to the Faraday Society and secretary to the Institute of Physics, has moved his office to 90 Great Russell Street, W.C.1 (Telephone, Museum 5718). The publishing office of the *Journal of Scientific Instruments* is now also at this address.

Our Astronomical Column.

The Lesser Magellanic Cloud.—There have already been several estimates published of the distance of this object. Prof. Harlow Shapley (Harv. Coll. Obs., Circ. No. 255) revises these in the light of new photographic determinations of the magnitudes and periods of the numerous Cepheid variables in the Cloud. The results point very consistently to a distance of 31 kiloparsecs or 100,000 light-years. He notes that Dr. R. E. Wilson's researches on the proper motions of galactic Cepheids tend to make the estimated distances of clusters and the Magellanic Clouds smaller by 20 or 30 per cent.; but that this reduction may be cancelled if Kapteyn's suggestion of systematic errors in the accepted proper motions in declination should be correct. He proposes, therefore, to postpone any correction till the question is settled.

The diameter of the Cloud is 6500 light-years, and its depth in the line of sight is presumably of the same order, so that it is no inconsiderable universe in itself. Its brightest stars are estimated to be of absolute magnitude −7·0, and diameter 1000 million kilometres, thus exceeding Betelgeux and Antares in size. It has been found possible to ascertain the general spectral types of some of them: types K5 and M occur among these, and the largest diameters are to be expected in these types.

The Cloud is receding with a speed of 170 km./sec., equivalent to a kiloparsec in 6 million years; Prof. Shapley suggests that it may have been a galactic star cloud 200 million years ago.

Distribution of Energy in Stellar Spectra.—The spectral energy curves of stars of types F5, A, and B have been measured by M. J. Baillaud, *Comptes rendus* of the Paris Academy of Sciences, May 12, and are found to be distributed into three groups, one for each type. The curve of Procyon (F5, dwarf) is the only one of those measured which approximates throughout to the "black body" form; those for types B and A have no relation to a black body curve, whatever temperature is assumed, at any rate for wave-lengths shorter than 500 mμ; it is thus impossible to use the curves for the determination of temperature. The author concludes that the origin of the observed continuous spectrum is not the same for the white stars as for the yellow; for the sun and dwarf stars like Procyon, the continuous spectrum apparently comes from a photosphere consisting of incandescent solid particles; for A and B stars the radiation seems to come from masses of gas at high temperatures; hydrogen and certain metallic vapours have been observed to emit continuous spectra, of a similar nature to those of these stars, in the laboratory. In certain cases, there appears to be a combination of the above sources of radiation; this may be due to the emission of black body radiation by a central nucleus, and of a high peaked continuous spectrum by surrounding gases.

Spiral Structure in Star Clusters.—Attention is directed by Dr. P. ten Bruggencate, in the *Zeitschrift für Physik* for June, to the discovery of remains of spiral structure in the B stars of the star cluster Messier 13, by Freundlich and Heiskannen. Dr. Bruggencate has plotted the bright and the fainter stars separately, on millimeter paper, for Messier 3 and Messier 15; and finds that the 150 bright stars of the former cluster show distinct signs of a spiral structure, while 270 fainter stars indicate an elliptical arrangement, the direction of the major axis of the ellipse being estimated with considerable certainty. Apparently the line joining the two points on either side of the cluster from which the arms of the spiral proceed, coincides in direction with the major axis of the cluster, as is required by the theory of Jeans. For Messier 15 there is not much evidence of spiral structure; but the Bonn catalogue is not sufficiently complete for accurate investigation of this cluster. Messier 37, which is an open cluster, shows Shapley's phenomenon, *i.e.* the giant stars are brighter the redder their colour, which indicates that they have a common origin; the complete catalogue of this cluster by v. Zeipel and Lindgren was employed, and it was divided into four concentric rings, the principal axis of inertia for the B and A stars of each ring being determined by counting. The direction of this axis was found to be constantly twisted in the counter-clockwise direction in proceeding outwards, the total observed twist being a little more than 45°. Thus even in an open cluster remains of a spiral structure may be found when the larger stars belonging to it are examined, the smaller stars which originally had a similar structure having become irregularly scattered.

Research Items.

DISINTEGRATION IN PRIMITIVE SOCIETIES.—Capt. G. Pitt-Rivers, in his presidential address to the Section of Ethnology and Anthropology of the Australasian Association for the Advancement of Science in 1923, which has recently been issued in the Report of the Association, offers some interesting suggestions in reference to tests which might be applied in estimating the trend of development in any given community, referring in particular to the changes which are brought about in a primitive society when in contact with white civilisation. For this purpose a comparison of different cultures and their social and moral systems is not adequate; but a standard or norm is to be found in the tendency to integration or disintegration. Taking, for example, the Papuo-Melanesian and Micronesian cultures, the principal factors of social integration are: (1) the chieftainship; (2) magic and sorcery; (3) the system of exchange of gifts, partly economic, partly ceremonial and non-economic. In the case of each of these the effect of contact with white civilisation has been disintegrative. In Papua the institution of a village policeman as the chief district authority has undermined the position of the chief without ensuring that the substitute shall be of a type to take his place in the native's estimation; while by suppressing sorcery and magic the administration has destroyed the strongest influence which made for law and order.

FORAMINIFERA OF LORD HOWE ISLAND.—Messrs. E. Heron-Allen and A. Earland (Journ. Linn. Soc., Zool., vol. 35, 1924) describe a collection of Foraminifera, made by Prof. R. D. Laurie at Lord Howe Island, South Pacific, which contains 199 species and varieties. Two new genera are described—Craterites, which is related to Orbitolites, and Diffusilina, the neatly constructed test of which and the high proportion of cement in its finished exterior surface indicate affinities with the Lituolidæ, but it has no close relationship to any previously recorded type. The authors direct attention to the profuse occurrence of species in reproduction, both by viviparity—young examples being found in a cavity resulting from the absorption of the internal septa of the test—and by "budding" from the aperture. The material was from the reefless area of the island only, and the authors believe that many species would have been added to the list if a collection had also been made among the reefs and in the lagoon. The material shows that a large proportion of the specimens are not of local origin but are more or less water-worn and have travelled some distance. Many of the species recorded have a wide range, from East Africa through the Malay and Australian seas to the Pacific.

MEDICAL PROTOZOOLOGY.—In a recent lecture on medical zoology (*Amer. Naturalist*, vol. 58, pp. 1-23, 1924) Prof. R. W. Hegner surveyed the recent investigations on protozoa carried on in his department of the Johns Hopkins University. He said that various theories had been put forward to account for relapses in malaria, and that one of these seemed now to be proved, for Dr. Ben-Harel had been able to show, by working on canaries infected with Proteosoma, that when parasites are apparently absent from the blood they exist in small numbers in the spleen and bone-marrow, where they undergo asexual reproduction in a normal manner. He referred to the work of Dr. Taliaferro on *Trypanosoma lewisi* in rats, and stated that pure lines of this species had been obtained by inoculating clean rats with single trypanosomes, and an intensive study had been undertaken of the resistance which the rat offers against infection. There are three manifestations of such resistance: (1) the rate of reproduction of the parasites is retarded until it is inhibited altogether by about the tenth day; (2) a large number of parasites are destroyed between the 10th and 14th days; and (3) the rest of the trypanosomes—non-reproducing adults—are finally destroyed. The first resistance is due to the formation in the blood of the rat of a reaction product which inhibits reproduction of the trypanosomes but does not destroy their vitality; the second resistance is as yet not explicable, but the third—the destruction of the organisms—is brought about by the formation of a lysin. Suggestive observations are recorded on the effects of a change of diet on *Trichomonas muris* in the cæcum of the rat—for when heavily infected rats were put on a well-balanced carnivorous diet for a week, the number of Trichomonas decreased almost to disappearance, apparently owing to alterations in the bacterial content of the cæcum and in the products of their activity. Prof. Hegner suggests that a carnivorous diet might be an effective method of treatment of flagellate dysentery in man, and states that the method has been put into practice in a few cases with "remarkably rapid and satisfactory" effects.

ACIDOPHILUS MILK.—Artificially prepared soured milks have been made use of as articles of diet in various parts of the world from time immemorial, and years ago Metchnikoff introduced the use of milk soured with the Bulgarian bacillus as a preventive of the onset of old age! Recently Prof. L. F. Rettger, of Yale University, has found that the *Bacillus acidophilus* produces a soured milk of considerable value in the treatment of intestinal toxæmias (*Science*: Science Service Supp., June 13). Skimmed cow's milk is boiled and cooled and inoculated with the organism, which is allowed to grow for twenty-four hours. At the end of this time the milk is curdled with a soft curd, and on shaking assumes the consistency of thin cream. Taken daily in quantities of from one to two pints, the fermentive and putrefactive bacteria in the intestines are much reduced in numbers with corresponding benefit in suitable cases.

TEMPERATURE IN THE NETHERLAND INDIES.—In Verh. No. 8, vol. 1, part 5, the Royal Magnetic and Meteorological Observatory of Batavia has recently published a discussion of temperature by Dr. C. Braak in continuation of other discussions on the climate of the Netherland Indies. A brief English summary is given as well as the full discussion in Dutch. Recent observations have been mostly used, as the older observations are generally untrustworthy, owing to defective exposure. Temperature is fairly uniform during the whole year, and in addition to the annual variation of winter and summer there is the influence of the monsoon. Whether the wind blows from south or north it brings air of equal temperature. Rain showers may cool the air temporarily, but generally uniformity of temperature is apparent. For daily differences in the dry season, the maximum temperatures are usually higher than in the wet season and the minimum lower, the daily range being greater in the dry season. The time of the maximum varies with the height above sea level, and the maximum occurs relatively early at the high mountain stations, where night frosts are occasionally noted in August and September. Diurnal variation of mean air temperature from observations in the Archipelago and in the adjacent Indian Ocean gives an extreme range of 0·87° C., while for the sea it is 0·75° C. The average air temperature is 26·05° C., the sea 27·10° C., the sea water being thus 1·05° C. warmer than the air. The decrease of temperature with increasing height in the free atmosphere is discussed, and the variation of soil temperature with depth. Monthly series of isotherms of air and sea over the adjacent waters, and

copious tables and diagrams, are given in the original text. The discussion is of the highest value for the advancement of the world's meteorology, dealing with the temperature of the part discussed in the most complete and scientific manner.

THE SURFACE LAYERS OF OCEANIC WATERS.—After studying the records of the *Challenger* soundings and plotting the density and temperature against depth, M. J. Thoulet has found that there is a limited layer, near the surface of the oceans, in which the denser water, due to evaporation at the surface, sinks, and is mixed by wave action with lighter water, containing less salt, produced by the action of rain, the melting of ice and the inflow of rivers (*Comptus rendus* of the Paris Academy of Sciences, May 12). The mean thickness of this layer of mixture, or of rapid diffusion, varies in different parts of the ocean between 600 and 800 metres, being greater in the tropics than near the poles; a layer of minimum density divides it from the lower oceanic water, where there is only slow diffusion. The paper gives an account of the seasonal variations of this upper layer, which cause a movement of water towards the poles in summer, and a reverse movement in winter. The density in the minimum density layer varies from 1·0289 in hot regions to 1·0253 near the poles, with a mean value of about 1·0275. It is particularly regular in the South Atlantic and the Pacific, where it is rarely so high as 1·0280.

THE VACUUM TUBE DISCHARGE.—In the July issue of the *Philosophical Magazine*, Sir J. J. Thomson puts forward a theory of the electric discharge in gases at very low pressures such as are used in the older X-ray tubes, which is in better agreement with the experimental facts than the theory which depends mainly on the collisions between cathode rays or positive ions and the molecules of the residual gas for the source of ionisation. The process which takes place in the tube is rather as follows. The positive ions on striking the cathode emit radiation which, falling on the cathode, causes a photoelectric emission from the cathode. The electrons emitted acquire a high speed, and cause the molecules of the gas to emit a second radiation, which in turn ionises the molecules it encounters. The recombination of the ions so produced constitutes the negative glow. On this theory, the difference of potential between a point in the dark space and the negative glow is proportional to the square of the distance of the point from the inner edge of the glow, which has been found to be the case by Dr. Aston.

ACTION OF A TRANSVERSE MAGNETIC FIELD ON THE CATHODE DARK SPACE.—A communication from the Physikalisch-Technischen Reichsanstalt in the *Zeitschrift für Physik* for May, by Dr. A. Günther Schulze, describes an ingenious device for obtaining a self-adjusting, plane, horizontal cathode, which allows the magnet poles to be brought fairly close together, and at the same time enables the glow discharge to be produced at a distance from the glass walls, so that it is unaffected by them. A glass tube, diameter 4 cm. and length 28 cm., is closed at one end, half filled with mercury, which forms the cathode, closed by a rubber stopper through which pass a glass tube connecting with the air pump and the connecting wires, and is laid horizontally between the magnet poles, so that the lines of force pass across parallel to the surface of the mercury cathode. The anode is near the stopper, and with a fairly high vacuum the glow discharge is deflected in a narrow band towards the sealed end of the tube. The width of the dark space, measured vertically, is obtained by means of a cathetometer; there is a minimum value for this distance d (*Fallraum*), which for all the gases investigated is near 0·70 mm.; for pressures of not less than 20 mm., d is very little greater than this minimum value with zero magnetic field; but for low pressures it is much larger, and can then be reduced to the minimum value when the field is increased sufficiently.

EXTRA HIGH FREQUENCY γ-RAYS FROM RADIUM.—The secondary β-ray spectrum from lead, excited by the γ-rays of radium and its disintegration products, has been photographed and investigated by M. J. Thibaud (*Comptes rendus* of the Paris Academy of Sciences, May 19). Eight lines have been found, the energy in kilovolts of each being as follows:

1	2	3	4	5	6	7	8
152	203	258	330	516	593	671	1034.

All of these lines correspond with lines in the spectrum of radium and its disintegration products; 1, 2, and 3 are identical with lines found by Ellis to belong to radium-B, 4 has been observed by de Broglie and Cabrera in the spectrum of the same substance, 5 corresponds to a β-ray originating in the K level of radium-C, 6 to one from the L level of the same substance; the difference between the energies of these two lines is 77,000 kilovolts, which agrees with the number, 75,000 kilovolts, calculated from other lines of the radium-C spectrum for these two levels. According to Ellis's theory, these lines may be due to a nuclear γ-ray, with energy 605,000 volts; while line 8 of the lead secondary spectrum, which corresponds to a line from the K level of radium-C, is due to a γ-ray with energy 1,123,000 volts. Lead, which was used as the secondary radiator, is an isotope of radium-B, and the production of lines 1, 2, 3, and 4 in its spectrum is to be expected. That the lines of radium-C are also obtained is regarded as due to the fact that the variation of the energies of the levels of radium-B and C is of the same order as the experimental errors.

SYNTHESIS OF METHANE FROM COAL GAS.—Work on the synthesis of methane from coal gas has been carried out in the laboratories of the South Metropolitan Gas Company, and some results were described at the annual meeting of the Institution of Gas Engineers. The preliminary complete purification of the gas from sulphur compounds necessary to avoid poisoning the catalyst involves the partial elimination of valuable unsaturated hydrocarbons from the gas, and the conversion of part of the carbon monoxide content of the gas to carbon dioxide. The loss resulting from these causes and the heat loss attributable to the exothermicity of the hydrogenation reaction would cause a considerable increase in the cost of the gas produced.

PHOTOGRAPHIC DEVELOPMENT AFTER FIXING.—Messrs. Lumière and Seyewetz have communicated to the Paris Academy of Sciences a method which places development after fixing upon a practical basis, which is recorded in the *British Journal of Photography* of June 27. Hitherto this process has required about ten times the usual exposure, presumably because the substance of the developable image, whatever it may be, is soluble in the "hypo" used for fixing. By adding a little ammonia to the "hypo." and to the wash water, this drawback is overcome. The developer preferred contains sodium sulphite and paraphenylene-diamine in addition to silver nitrate, and yields negatives that recall those on collodion plates in appearance and other characteristics. The developer is exhausted in about an hour, and if more density is required it may then be replaced by a fresh portion, and thus continued up to 10 or 12 hours' duration. By this longer time the particles are about equal in size to those of the original silver bromide of the plate. Photomicrographs are given of the grain produced by development for 1, 3, 7, 24, and 48 hours. Even the coarsest grained plate gives a fine grained image unless development is unduly prolonged or the image is intensified.

The Kelvin Centenary.

IN the presence of a large and distinguished company, including delegates from the principal scientific societies of Great Britain, the British Dominions, Belgium, Denmark, France, Italy, Japan, Mexico, the Netherlands, Norway, Poland, Russia, Spain, Sweden, Switzerland, and the United States of America, Sir Charles Morgan (president of the Institution of Civil Engineers) handed the Kelvin medal to Prof. Elihu Thomson in the great hall of the Institution of Civil Engineers on Thursday, July 10.

In making the presentation, Sir Charles Morgan explained that the medal (Fig. 1) was founded in 1914, principally by British and American engineers, to commemorate the advancement by Lord Kelvin of those branches of science which are especially applicable to engineering. The award is dealt with by a committee of the presidents of the representative British engineering institutions, after their consideration of recommendations received from similar bodies in all parts of the world, and, in accordance with the terms of the trust, it is made to the person whom the committee finds to be the most worthy to receive this recognition of pre-eminence in the branches of engineering with which Lord Kelvin's scientific work and researches were identified. The only previous award of the medal was that made in 1920 to Dr. W. C. Unwin, whom he was glad to see present. He reminded his hearers that Prof. Elihu Thomson has been connected with the applications of electricity to lighting and power from the early days of the Thomson-Houston arc lighting system to the vast present-day activities of the General Electric Company of Schenectady. Prof. Thomson has made far-reaching discoveries relating to alternating and high-frequency currents and was a pioneer in electrical resistance welding. A past president of the American Institute of Electrical Engineers, he has been the recipient of many high honours. In receiving the medal, Prof. Elihu Thomson said that he regarded the award as a compliment not only of a personal nature but also to the whole American electrical engineering profession. He liked to think of Lord Kelvin as the supreme example of what a man of engineering science could be.

Sir Richard Glazebrook then took the chair and directed attention to the great progress achieved during the hundred years that they were looking back upon. To this progress, no one had contributed more than the great man whose memory they were met to honour that day. The celebrations originated in a suggestion of Dr. Alexander Russell (president of the Institution of Electrical Engineers), but they were being taken part in by a long list of British institutions and by delegates from foreign societies, who had come from all parts of the world to do honour to Lord Kelvin's name. The chairman then received addresses in writing from a large number of foreign delegates who were present.

Sir Joseph Thomson.

Sir Joseph Thomson then proceeded to deliver the Kelvin oration. In his opening remarks, he characterised Lord Kelvin as the Admirable Crichton of physical science. A great physicist, he was at the same time a great mathematician and a great engineer. He could make inventions as well as he could write text-books, and could take out patents as well as he could write papers. Few men had sprung to fame at such an early age. Born at Belfast, where his father was professor of mathematics, he commenced his studies at Glasgow at ten years of age, when his lifelong connexion with that city and university began. Before he was eleven he had won two prizes in mathematics, and before he was thirteen he had gained further distinction in this subject as well as in natural philosophy and logic. During these early years, his thoughts were turned to two subjects which were destined to play great parts in his subsequent career, the figure of the earth and Fourier's theorem. His later work with regard to the former produced one of his most important contributions to physics, and the latter formed the underlying basis of much of his other work. William Thomson, as he then was, went into residence at Peterhouse, Cambridge, in 1842, and was soon recognised as the most brilliant mathematician of his year, although he had to be content with the position of second wrangler in the mathematical tripos of 1845. He was, however, easily first in the examination for the Smith's Prize in the following year. After taking his degree, he worked for a few months in the laboratory of Regnault in Paris. This had a great influence on his career, not only in familiarising him with laboratory methods but also in introducing him to the work of Sadi Carnot, on which the second law of thermodynamics

WILLIAM · THOMSON · BARON · KELVIN · O.M.
FOUNDED · BY · ENGINEERS · 1913
IN · MEMORY
OF · BARON · KELVIN
OF · LARGS
ENGINEER · AND
NATURAL
PHILOSOPHER
BORN 1824 · DIED 1907

FIG. 1.—The Kelvin Medal.

was afterwards based. In October 1846 he was appointed to the chair of natural philosophy at Glasgow, which he held with such brilliance for fifty-three years, soon extending the meagre facilities for experimental demonstration which he found there. Throughout his professorial career he may be said to have acted rather as an inspirer than as an instructor. He filled the ablest students with enthusiasm, the others with despair.

The decade of 1850–60 saw the establishment of the second law of thermodynamics, and Kelvin's work in this connexion has claim to be regarded as the most important of his many important contributions to physics. Continuing this work, he published in 1851 a paper expounding the position of thermodynamics in a masterly way, introducing the idea of an absolute scale of temperature corresponding to the readings of the gas thermometer. He also found time to devote to thermo-electricity and magnetic and other problems. It is important to record that his paper on transient electric currents in 1853 revealed the discovery of the oscillatory nature of the discharge of a condenser in certain circumstances, which is the basis upon which the whole study of electrical oscillations and wireless telegraphy and telephony is founded. In further papers he dealt without intermission with discoveries of fundamental importance in nearly every branch of physics. An outstanding feature of his equipment for the attack of dynamical problems was his engineer's intuition of how matter in motion would behave. The secret of his success in applying mathematics to physical problems was that he knew what to expect. With his striking originality, he was greater in developing his own methods than in following the lead of previous workers. In this respect he might be described as a good radiator but a bad absorber. For sixty years he worked at the elucidation of the theory of the luminiferous ether, and no small proportion of his total of 661 papers is devoted to this subject. Although he had to admit failure as regards direct results, a good deal of benefit arose indirectly from these investigations. The lecturer referred briefly to the new outlook opened up in the teaching of dynamics, etc., by the publication of Thomson and Tait's work on natural philosophy, to Lord Kelvin's fascination by gyrostatic problems, and his theory of the age of the earth, which was afterwards invalidated by the discovery of radio-activity.

It was in 1855 that Kelvin first turned his attention to submarine telegraphy and took up the study of the propagation and retardation of currents in cables, and his first connexion with Atlantic cable enterprise was his election, in 1855, as a director of the Atlantic Telegraph Co. to represent the Scottish shareholders. He soon took a more active part and accompanied the original unsuccessful expedition on the *Agamemnon* in 1857, and the expedition in the following year, when only brief communication was established, as well as the final successful expedition of 1866. It is well known that the conversion of failure into success was in no small degree due to the ability and courage with which he faced the problems involved and to the instruments, including the marine galvanometer and the siphon recorder, which he devised. His instruments of another type revolutionised the practice of electrical measurement generally; and the formation of the British Association Committee of 1861 on electrical standards was mainly due to him. It was he who devised the first method of measuring resistance absolutely by the spinning coil.

Kelvin was a keen yachtsman, and his interest in the sea led him to make most important contributions to navigation in his deep-sea sounding machine, tide predictor, and other apparatus. In addition to the direct results of his investigations, he produced great effect on scientific progress indirectly by the enthusiasm which he stimulated in others. This was very particularly seen at the meetings of Section A of the British Association, which his personality filled with life and interest. Kelvin was a man of outstanding vigour in the union of theory and practice and in untiring devotion to a great idea.

Dr. Alexander Russell.

An inspiring account of Kelvin's life and work was given by Dr. Alexander Russell in an oration delivered at the centenary commemoration at the University of Glasgow on June 25 and published in pamphlet form. Dr. Russell, himself an old student of Glasgow who attended Kelvin's lectures, spoke of Kelvin's belief that the chief importance of science lay in its applications for the material benefit of the human race, and his unbounded enthusiasm in applying it to ameliorate our everyday life. He was impatient of the slow progress made in improving means of communication, systems of lighting, and methods of transport by land and sea. His vivid imagination saw the world as it might be if science, engineering, and human labour had no limitations.

Dr. Russell proceeded to outline Kelvin's early years at Belfast, his brilliant career as a student at Glasgow and Cambridge, and his subsequent greatness as a professor, and spoke of the importance of his original work in mathematical physics generally and particularly in thermodynamics, submarine telegraphy, terrestrial magnetism, and the oscillatory discharge of the Leyden jar, and his applications of the theories of gyrostatic action and vortex motion. Kelvin was also greatly interested in atmospheric electricity and his well-known navigational instruments include his deep-sea sounding machine, his tide predictors and analysers, and his famous magnetic mariner's compass. It is not so generally known that he was also a pioneer of the gyrostatic compass, of which he made a model in 1884. The wonderful series of electrical measuring instruments designed by Kelvin bears witness to his energy, his inventive skill, and his practical genius. His electrometers and electrostatic voltmeters are in use in every country of the world to-day. In 1878 he pointed out how simply electrical energy could be transmitted over great distances, and his law determining the size of mains has done much towards cheapening the cost of electrical distribution. Attention was also directed to the importance of his work on electrical units and standards. "For the number, variety, and importance of his great contributions to science," continued Dr. Russell, "he stands without a rival. His works are a gift to universal Humanity. Had it not been for Kelvin the world would have been perceptibly poorer to-day. . . . And as the years roll on our debt to him grows ever greater."

Overseas Electrical Engineers.

A large party of representatives of overseas electrical engineering institutions who are visiting England, partly in connexion with the World Power Conference at Wembley, was entertained during the past week by the Institution of Electrical Engineers. The proceedings, which were to some extent combined with the Kelvin centenary celebrations, were inaugurated on Wednesday, July 9, at a reception at the Institution building on the Victoria Embankment, when the president, Dr. Alexander Russell, gave a brief address of welcome to the visitors. In the course of his address, he emphasised the truly international character of electrical science as evidenced by the names of our electrical units commemorating

great workers from many lands. It was particularly fitting that their visit coincided with the Kelvin centenary celebrations and the award of the Kelvin medal to Prof. Elihu Thomson, the successor of Lord Kelvin as chairman of the International Electrotechnical Commission. In another American representative they were glad to welcome Prof. Kennelly, of Harvard. Prof. Keith (secretary of the Engineering Institute of Canada) replied on behalf of the visitors, and in paying tribute to the work of Lord Kelvin referred to the part that he had played in the early days of the harnessing of Niagara. Representatives were present from the following societies: The American Institute of Electrical Engineers, Associacion de Ingenieros de Caminos, Canales y Puertos (Madrid), Associazione Elettrotecnica Italiana, Dansk Ingenirforening, Norske Ingenirforening, Engineering Institute of Canada, Institute of Engineers (India), Institution of Engineers (Australia), Koninklijk Institut van Ingenieurs (Holland), Schweizerischer Electrotechnischer Verein, Société Belge des Électriciens, Société Française des Électriciens, South African Institute of Electrical Engineers, Svenska Teknologforeningen, Vereening van Directeuren van Electricitatabedrijvenin Nederland, and other bodies.

The reception was followed by a luncheon at the Hotel Cecil, at which some three hundred members and guests sat down. The toast of the visitors was proposed by Mr. Ll. B. Atkinson (past president), who included in his speech a few words of welcome in nearly every language of the visitors, and was responded to by Mr. J. W. Lieb (past president of the American Institute of Electrical Engineers). Most of the visitors attended at the presentation of the Kelvin medal to Prof. Elihu Thomson and the delivery of the Kelvin oration by Sir Joseph Thomson at the Institution of Civil Engineers in the afternoon. The full programme of entertainment of the visitors, as we have already announced, included the Kelvin banquet on Friday, July 11, and visits to Wembley, Cambridge, the Birmingham district, and Windsor, and a lunch on Tuesday by invitation of Lord Ashfield, chairman of the Underground Electric Railways of London, Ltd.

Electrical Progress and its Unsolved Problems.

THE above was the title of the James Forrest lecture delivered at the Institution of Civil Engineers on Tuesday, July 8, by Prof. Elihu Thomson. The lecturer recalled Col. Crompton's James Forrest lecture in 1905 entitled "Unsolved Problems in Electrical Engineering," and proposed to deal with similar matters from the present point of view, directing attention to the recent advances in various departments of electrical work.

Speaking first of the electrical phenomena in Nature, Prof. Thomson referred to terrestrial magnetism, and made the suggestion that the oxygen in the atmosphere, being magnetic in property, must in a measure influence the direction of the lines of dip within the atmospheric layer. Of all natural electrical manifestations the thunderstorm is the source of most difficulty in electrical undertakings. The view of its cause now generally adopted is that of Simpson, making it a water-drop phenomenon. With the rapid passage of condensed drops through an uprising current of air, a fine spray is torn from them carrying a negative charge, and leaving the diminishing drops positively charged. The lecturer inclined to the view that the lightning flash is more of a steep wave-front discharge in one direction than a true oscillatory discharge. This, however, does not prevent structures capable of oscillation being activated by the shock of a heavy discharge. There are still many unsolved problems connected with protection of electrical apparatus and lines from the effects of lightning, but with increased transmission voltages and their greater degree of insulation, lightning troubles may be expected to diminish. For the protection of buildings, however, there is ample security in the intelligent application of the principle of providing a best path to earth. The so-called "ribbon" discharges, or successive discharges down the same ionised air streak, stationary or travelling with the wind, are the most dangerous. With regard to the explanation of globular lightning, which undoubtedly exists, little progress has been made.

Magnetic storms and auroræ are now generally recognised to be connected in some way with sun-spot conditions. It would seem that from the spot areas, streams of electrified particles are projected at speeds possibly up to 2000 miles per sec. If the earth is moving in its orbit near such a stream a disturbance of the magnetic field is inevitable. When the earth is directly immersed in the stream, the outer thin envelope of gas entangles the electric particles, resulting in a decided elevation of charge or potential of the outer partially conducting layer. This charge may be carried around with the revolving earth, so that on the dark side a discharge takes place into the shadow of the earth, continuing until the received charge is exhausted, or there is no further entrance or absorption of ions on the side towards the sun. This would account for the fact that most short-lived auroræ begin in the evening, and for the induced effect on telegraph lines during the disturbance.

The old phenomenon of St. Elmo's fire has in late years a counterpart in the corona surrounding high-voltage lines, which, since it involves a loss of energy, should be avoided by increasing the wire diameter or otherwise, such as possibly by jacketing the line with hollow beads or shells. The same potential limitation exists in wireless antennæ, where corona discharge is apt to produce distortion as well as loss of energy.

Turning to questions of transmission of energy, Prof. Thomson said that in the broadest sense all transmission of energy is electrical in its nature, as all the properties of matter now seem to be fundamentally electric. He dealt briefly with the conditions of transmission lines, recalling that the flow of energy itself is not in the conducting wire but in the space surrounding it. In ordinary low-frequency currents little of the energy is radiated away into the space. At high frequencies the radiation loss is a measurable quantity, and at the highest frequencies, as used in wireless transmission, practically all the energy is radiated. In the past few years, the advances made in this form of electric transmission have given rise to a new art of unprecedented importance in the future. The lecturer dwelt upon some of the features of this advance, particularly in the development of the three-electrode thermionic valve, and mentioned interference of conditions of land surface, atmospherics, and "fading" as among the unsolved problems. He was inclined to think that the last-mentioned may be caused by displacement of phase relations by changes in the electrical condition of the lower atmosphere preceding distant lightning discharges.

Outside of high-frequency work, most of electrical engineering is based on the magnetic properties of iron, and although no great advance on the high figures of efficiency now attainable may be expected,

no definite limit can yet be set upon the reduction of iron losses by improved material. The recently discovered "Perm-Alloy," which magnetically saturates even in the earth's field alone, points the way to improvements in instruments, and raises questions as to the possible discovery of other alloys with equally surprising magnetic qualities. It is not to be expected that any real substitute for copper as a conductor can be found, although aluminium can sometimes be substituted for transmission lines, and its higher resistance is even an advantage in certain cases of rotors of induction motors. In the matter of insulation, however, there will always remain room for further advances. The difficulties in the design of large generators are now mechanical rather than electrical.

Applications of electric transmission of power of another kind were mentioned in electric ship propulsion now applied to the largest battleships, to transmit power from the high-speed turbines to the low-speed propellers with advantages of efficiency and facility of control, and in other craft in connexion with Diesel and other oil engines as well as on land in Diesel locomotives, "petrol electric" automobiles, etc. The still unsolved problem of continuous or alternating current motors for railway traction was also dealt with, and other points in connexion with electric traction referred to included modern methods for suppressing flashing over at the commutators of rotary converters, and improved forms of control, including automatic control of sub-stations. In connexion with the beginnings of so-called "super-power" systems, an important problem is the control of power factor, and there is room for improved construction of static condensers for this purpose.

Passing on to the application of electricity for the production of heat, the lecturer indicated that it is more in localised heating for special purposes, or in the production of very high temperatures, that the field of electricity lies, than for the general warming of buildings. He dealt at some length with the possibilities of electric resistance welding of the "flash" and "spot" welding varieties, which is fast superseding riveting in a great variety of work. Arc welding has also considerable application. In electric furnace work a recent development is the Northrup high-frequency induction furnace in which iron cores are dispensed with and currents induced in the crucible at a frequency of the order of 10,000 cycles per sec. It is possible that currents of the necessary high frequency may be provided by valve or arc generators instead of special high-frequency alternators. The great advantage of electric heating in furnaces is the excellent control of temperatures and exclusion of gases. Electric heating can be carried out in vacuo, or, on the other hand, high pressures may be used with suitable furnace design.

Dealing with electric lighting, the lecturer traced the progress from the open carbon arc to modern magnetite and other arc lamps considerably used in America, and often in conjunction with mercury vapour rectifiers, and in the incandescent lamp, from the carbon filament lamp of forty years ago to the gas-filled tungsten lamp of to-day. It would seem, he said, that but little further advance in this field is to be expected. There is, however, much room for improvement in the application of the lighting units in illumination.

Reviewing the situation regarding storage batteries, Prof. Thomson expressed the view that the ideal has not yet been reached either in the lead battery or in the nickel-iron cell, both of which have serious disadvantages, especially for electric vehicle work. Even the latter, useful as it may be in certain circumstances, does not provide a true solution of the storage battery problem; "perhaps," he continued, "there is no solution possible."

There are many directions in which it is impossible to predict the developments of the future. "Who is there," Prof. Thomson said, "to tell us of the momentous issues and events which may arise out of the studies in pure science, of atomic and molecular structure, and the energy relations involved, which have become in large measure the chief study in physical science of our day? Perhaps our comparatively feeble beginnings in thermionic emission and the manipulation, so to speak, of electric ions, infinitesimally small though they be, coupled with the knowledge of the electric structure of matter in all its forms, may be the foundation of a greater superscience of electricity of enormous importance to the future achievements."

University and Educational Intelligence.

ABERDEEN.—At the Summer Graduation on July 10 the honorary degree of LL.D. was conferred on Dr. Michael Comport Grabham. Dr. Grabham delivered a lecture on July 9 on the "Natural History of Madeira."

The degree of D.Sc. was conferred on Mr. H. E. Magee, for a thesis on "The Influence of Food on the Respiratory Exchange of the Ruminant."

EDINBURGH.—The following are among the changes announced recently in the staff of the University: Prof. J. C. Meakins, professor of therapeutics, is leaving in September to take up his duties as professor of medicine, McGill University, and physician-in-chief in the Royal Victoria Hospital, Montreal; Dr. Bevan B. Baker, lecturer in mathematics, is resigning on being appointed to the chair of mathematics in the Royal Holloway College; Dr. O. S. Gibbs, lecturer in materia medica, has left to take up duties as professor of this subject in Dalhousie University, Halifax.

Dr. Frederick Walker, research student in the Geological Department of the University, has been awarded a Rockefeller Travelling Fellowship by the International Education Board. Dr. Walker will undertake petrological research in the Geophysical Laboratory of the Carnegie Institution of Washington.

LONDON.—The hundredth anniversary of the foundation of University College will be celebrated in 1926, and Sir Gregory Foster asks members and friends of the College to send records, reminiscences, pictures, photographs, etc., which are being collected with a view to the production of a history of the College as a part of the Centenary Celebrations. All documents will, in due course, be returned unless the owners desire to present them for the College archives. Communications and parcels (marked "Centenary") should be sent to Sir Gregory Foster at the College.

The Sharpey Physiological Scholarship, of the annual value of 160*l*., founded in memory of Prof. William Sharpey, will shortly be filled, on the recommendation of the Faculty of Medical Sciences of University College, London. The Scholar has opportunities for research, and takes a small share in teaching and demonstrating to students. Applications should be sent to the Secretary of University College, London (Gower Street, London, W.C.1), not later than Saturday, July 26.

ST. ANDREWS.—Applications are invited for the post of lecturer in chemistry in University College, Dundee. Preference will be given to candidates who have specialised in physical chemistry. Applications should be received (in triplicate) by the Secretary of the University by, at latest, August 31.

SHEFFIELD.—The following appointments have been made: Dr. G. A. Clark, to a lectureship in

physiology; Mr. E. F. Baxter, to an assistant lectureship in mathematics.

THE Technical College, Bradford, invites applications for the headship of its newly established department of commerce and banking. Particulars of the post and forms of application may be obtained from the principal, to whom the completed forms must be returned by, at latest, July 28.

THE British Research Association for the Woollen and Worsted Industries is inviting applications, to be received not later than July 31, for research fellowships and advanced scholarships. The fellowships will each be of the maximum annual value of 200*l.*, and are tenable, in the first place, for one year, at an educational institution or elsewhere if suitable resources are available. The advanced scholarships are open to students and others, and are designed to enable the scholar to specialise. Courses of training in research work should generally be included in a candidate's proposed curriculum. Applications, with particulars of past records, proposed course of work, and so on, should be addressed to the Secretary, British Research Association for the Woollen and Worsted Industries, Torringdon, Headingley, Leeds.

EDUCATIONAL RESEARCH appears to have been pursued during the past two or three years with extraordinary enthusiasm in the United States. According to the Biennial Survey, 1920–22, of the Bureau of Education (Bulletin, 1923, No. 42) no less than 80 city, state, and university bureaus for educational research have been maintained, experiments were extensively carried on in all phases of school administration and instruction in numerous institutions, including 22 college and university laboratory schools and about 50 experimental schools for "progressive education," while from numerous presses issued an abundant stream of articles, monograph series, reports, and books. Among the national educational organisations which play a prominent part in promoting educational research are the American Council on Education (now closely associated with the American University Union in Europe), which studies the larger questions of educational policy, the Educational Research Association, the National Society for the Study of Education, the National Society of College Teachers of Education, the Carnegie Foundation for the Advancement of Teaching, and many others. The Bibliography appended to the Bulletin comprises 543 items. Those classified under organisation and administration deal largely with plans for classification in ability groups to the end that America may have no mute inglorious Miltons.

THE following awards, tenable at the Imperial College of Science and Technology, South Kensington, during the year 1924–25, have been made by the Governing Body of the College: (*a*) The Henry George Plimmer Fellowship in pathology to Mr. H. R. Hewer, for a continuation of his research on "The Rôle of Stimuli received by the Eye in the Colour Changes of Amphibia and Nerve Supply of the Pituitary"; value about 300*l.* (renewal). (*b*) The Gas Light and Coke Company's Research Fellowship, established by the Company for the purpose of encouraging experimental research in relation to carbonisation, gaseous fuels and combustion, to Mr. F. R. Weston, for a continuation of his research on "The Spectroscopic Investigation of the Flames of Carbon Monoxide and Hydrogen and matters cognate thereto"; value 200*l.* (renewal). By the Trustees of the Beit Fellowships for Scientific Research: Research Fellowships of the value of 250*l.* each to Mr. O. M. B. Bulman, for a continuation of his work on "Stratigraphical Geology; The Fauna of the Shineton Shales" (renewal); Dr. W. E. Downey, for research on "Photochemical Problems"; Mr. L. A. Harvey, for research on "The Nature and Function of the Cytoplastic Inclusions (Mitochondria and Golgi Bodies) in the Cells of Vertebrates"; Mr. R. Quarendon, for research on "The Combustion of Gases in Nitrous Oxide."

THE *University Bulletin* issued by the Association of University Teachers has until recently been confined mainly to recording the activities of the Association. The June number includes several articles of a more general nature. Among these is one by Dr. Brodetsky, reader in mathematics in the University of Leeds, on the anti-Jewish policy said to be prevalent in certain universities in Poland and Austria. The admission of Jews to these universities is severely restricted by applying what is known as the "Numerus clausus" principle, which consists in limiting the proportion of students belonging to a particular race to the ratio between the total number of persons of that race in the country and the total population of the country. Many Jews have in consequence gone from Austria to Italian universities, where they are welcomed. In an article on "A new residential university," Principal Childs, of University College, Reading, describes the circumstances in which his college is renewing its application for the grant of a university charter. Faculty organisation is discussed by Mr. C. B. Fawcett, reader in geography in the University of Leeds, who advocates reversion on the part of the newer universities to the medieval plan of a general faculty for all non-professional studies and the discontinuance of the practice of awarding several different first degrees—B.A., B.Sc., B.Com., a practice which makes for confusion and misunderstanding, and obscures the essential unity of knowledge.

THE progress of engineering education in India in recent years cannot be said to have kept pace with industrial developments. The official quinquennial Report on Education in India, 1917–22, shows that although during this period expenditure on colleges of engineering and other technical and industrial schools increased by 80 per cent., the number of students in the four Government engineering colleges decreased from 1319 to 1236, and in the other institutions increased only from 13,202 to 15,000. Doubtless there is in India a considerable amount of education in engineering which does not figure in the official returns, but in view of the extent and importance of industrial enterprises already established and the boundless field open to development, these figures must be regarded as astonishingly small, and suggest the question: What would have been the condition of India to-day if the Government's expenditure during the past fifty years on education had been directed by a policy aiming primarily at the development of the material resources of the country instead of being devoted almost exclusively to the dubious benefits of literary curricula on the lines of those of western schools. In Western India, there are signs of a growing appreciation of the benefits of engineering and other technical education, there being keen competition for admission to such institutions as the N.E.D. Civil Engineering College at Karachi, the Victoria Jubilee Technical Institute of Bombay, and the Poona Engineering College, notwithstanding that comparatively high fees are charged.

Early Science at the Royal Society.

July 17, 1661. Sir Paul Neile having mentioned, that the king had, within four days past, desired to have a reason assigned, why the sensitive plants stir and contract themselves upon being touched; it was resolved, that Dr. Wilkins, Dr. Clarke, Mr. Boyle, Mr. Evelyn, and Dr. Goddard, be curators for examining the fact relating to those plants.

July 20, 1664. Notice being given, that some ships were ready for Guinea, it was desired, that such, as had inquiries to be made in those parts, might prepare them against the next meeting.

1687. Mr. Hooke shewed the experiment of vibration of the rods, as a pendulum, which was by suspending a large Indian-cane of about thirty feet long by two pack-threads about eight feet in length: by which it was plain how the weight of such rods or poles for communication of traction or pulsion at a distance might not only be made to move freely and with ease, but also be in the nature of a sway. The same thing was also tried with a large scaffold-pole of about forty feet long.

July 22, 1663. Sir Robert Moray mentioned, that the king had made an experiment of keeping a sturgeon in fresh water in St. James's Park for a whole year: it was moved to kill it, and to see how it would eat.—He related that prince Rupert had made a new kind of gunpowder, in strength so far exceeding the best English powder, that trial being made with a powder-trier, it was found to be in the proportion of 21 to 2. It was desired, that a trial of it might be made before the society.

1669. The society being made acquainted by Mr. Oldenburg, that Mr. Edward Diggs intended to go shortly to Virginia, and offered his services for philosophical purposes; it was ordered that the inquiries formerly drawn up for that country should be recommended to him.

July 23, 1662. The amanuensis was ordered to translate from the French Monsieur Huygen's letter to Sir Robert Moray, dated at the Hague, July 14, 1662, containing some objections to some parts of Mr. Boyle's "Defence of the doctrine touching the spring of the air" against Franciscus Linus and Mr. Hobbes.

1684. Upon a complaint of Mr. Flamstead, that he had been reflected upon by Mr. Hooke in the minutes of the society, it was ordered that a line should be drawn through the places complained of, and that there should be written on the side, "cancelled by order of council": and that the journal-book should be brought to the next meeting of the council, who should see it done.

July 24, 1679. Mr. Haak produced a book intitled "Propositions of Optic Glasses," printed at the theatre at Oxford. Mr. Hooke who had read somewhat of the book, said, that he had not found anything in it, which was new, and that it contained some propositions about the place of the image, which were not true: that it came far short of the theory of optics now well known, which he conceived to have been first well understood by Kepler, and highly improved by Des Cartes.

July 25, 1667. The experiment of opening the thorax of a dog made at the last meeting not having succeeded, it was ordered to be made again at the next; and Dr. King was desired to bring in writing an account of that whole operation, though it failed.

July 26, 1682. Dr. Grew read a letter from Dr. Coga, Vice-chancellor of the university of Cambridge, wherein he mentioned, that Hevelius's last book was not to be found in that university.

Societies and Academies.

LONDON.

Physical Society, June 13.—Mr. F. E. Smith in the chair.—G. E. **Bairsto**: On a method for the synchronous and instantaneous illumination of objects rotating or vibrating at very high speeds. It is capable of giving instantaneous photographic records, and gives a precision of the order of half a microsecond. It is much more precise and able to give a more intense spark than any contact breaker and coil method.—E. A. **Owen, N. Fleming,** and Miss W. E. **Page**: The absorption and scattering of γ-rays. The absorption and scattering of γ-rays from radium filtered through 23 mm. of lead have been measured in magnesium, aluminium, zinc, tin, and lead. Assuming that the mean effective wave-length of the radiation employed is 0·021 Å, the experimental results are consistent with the following statements: (i.) When γ-rays traverse matter, the characteristic radiations of the absorbing medium are excited; (ii.) the atomic fluorescent absorption coefficient of γ-rays depends upon the wave-length of the incident radiation and the atomic number of the absorber according to the law $\tau/\rho.\omega = K\lambda^3 N^4$, which holds for X-rays; (iii.) the radiations which accompany this fluorescent absorption are the characteristic radiations of the K, L, M, . . . series of the absorbing elements; (iv.) the absorption of γ-rays in light elements is due almost entirely to scattering; (v.) the pure atomic scattering absorption coefficient is proportional to the atomic number of the absorber; (vi.) in addition to fluorescent and scattering absorption, a true absorption exists, the atomic coefficient of which is proportional to the atomic number. Compton's formulæ would account for the experimental results if the wave-length of the incident radiation were 0·020 Å. Jauncey's formulæ would require the wave-length to be 0·029 Å.—W. N. **Bond**: The flow of compressible fluids, treated dimensionally. The method of dimensions treatment that is applicable to the pressure gradient at a point in a system through which non-compressible fluids of finite viscosity are passed, is extended by means of the thermo-dynamical equations for gas flow to the case where appreciable changes in density of the fluid occur, but where no heat passes across the walls of the system. The theory is developed in detail only for the case of flow through a straight parallel-walled tube, and has been tested by experiments in which water and air at high velocities pass through small tubes. The air in some experiments had a velocity of more than two-thirds of the velocity of sound in the air. Errors due to moisture, pulsating flow, heat conduction through the walls, and proximity to the entrance to the tube are small; an error of moderate amount is attributed to the partial neglect of the variation of the variables over the transverse section of the tube.—D. B. **Deodhar**: Note on Israj, a remarkable Indian stringed instrument.

Aristotelian Society, June 16.—Prof. T. Percy Nunn, president, in the chair.—A. D. **Lindsay**: Sovereignty. The theory of sovereignty is the storm-centre of political theory. For one school it is inherent in the very conception of government, for another it is nothing but a stone of stumbling, an anachronistic theory to be got out of the way as the essential preliminary to any solution of social questions. Austin approaches the doctrine of sovereignty with the purpose of defining law. Law is essentially a command and depends therefore on a distinction between the sovereign and the subjects. The originality of his theory is that he gives up all attempts to derive the

right of the sovereign from a supposed social contract, and bases it on the previous relation between him who commands and him who obeys. The command is a law consisting in the fact that the person who obeys has been in the habit of obeying the person who commands. Sovereignty is thus based on fact. As constitutional government developed, political theorists tried to describe it in terms of sovereignty. They invented a new kind of person, the people, the general will, the state or the nation, which they distinguished from the individuals composing the community. Bosanquet's "Philosophical Theory of the State" is a theory of sovereignty which he describes as "the general will" and represents as diametrically opposed to the Austinian. He is dealing, however, with a quite different question. He is showing that the real basis of law, as of everything else in society, is the whole of society. What is wanted is a link between this common life of society and the political machinery. The true theory of the sovereignty of the constitution maintains that the link between the social and juristic aspect of the State is the adherence by the great mass of the members of a society to a definite principle of settling differences.

Mineralogical Society, June 17.—Dr. H. H. Thomas, vice-president, in the chair.—Miklós **Vendl**: The chemical composition and optical properties of a basaltic hornblende from Hungary. Complete determinations were made, all on the same sample of material, of crystals of a black hornblende occurring in volcanic tuff near Lake Balaton. The mineral is rich in titania, alumina, ferric iron, and alkalis, and the composition is expressed by the mixing of simple metasilicate molecules (including 14·62 per cent. H_2SiO_3) with aluminate (14·40 per cent. $MgAl_2O_4$) and ferrate (4·32 per cent. $MgFe_2O_4$).—G. **Abbott** and W. A. **Richardson**: The micropetrography of the structures of the magnesian limestone of Fulwell. The structures of the magnesian limestone show a wide variety of forms ranging from simple spherical concretions to highly complex coral-like masses. The more complex types are built up by a combination of rods, tubes, and bars. The microstructure shows more uniformity. The prevailing type is finely granular but crystalline. Where impurities or lines of pigmentation are present the matrix becomes quite microcrystalline as a rule, whilst on the borders of cavities there is a coarser growth. Banded pigmented forms show the same structure as banded chert. Spheroids have either a coralloid structure, or if solid are microcrystalline at the centre with a radial crystallisation towards the surface. The microstructure by itself throws little light on the origin.

Royal Statistical Society, June 17.—J. **Hilton**: An inquiry by sample: an experiment and its results. At the end of 1923 a need was felt of a more detailed and intimate analysis of the million and a quarter or more workpeople in Great Britain who were then being returned week by week as unemployed; and it was evident that such an investigation must be by sample, and that the information desired was of a kind that necessitated personal interviews. It was decided to "tab" every hundredth claim on the live claim file at each Exchange, and invite the claimants thus indicated to attend in the manager's room for interview. Every Exchange was given a different point on its live claims file at which to start, and the starting points were distributed as evenly as possible over the whole occupational classification. The interviews took place in the week ended November 10, 1923, and 9997 reports were received. Comparison with the results of previous inquiries showed that the 1 per cent. sample is nowhere very wide of the mark, and has answered most of its purposes quite as well as a 10 per cent. or 33 per cent. inquiry. The sample only becomes untrustworthy when very small absolute numbers are involved.

Royal Meteorological Society, June 18.—Mr. C. J. P. Cave, president, in the chair.—C. K. M. **Douglas**: Further researches into the European upper air data, with special reference to the life history of cyclones. The temperature in the troposphere is much higher over a Bjerknes' "warm sector" than over the other parts of a cyclone. This leads to the conclusion that a cyclone is superficial in its initial stages. Relevant observations are few, since the development of a cyclone usually takes place in the Atlantic. A large part of the great increase of kinetic energy observed when a cyclone develops is supplied by a convectional overturning between adjacent warm and cold masses of air. The cold mass must have a depth of fully 6 or 7 kilometres, or about the depth of the troposphere in high latitudes in winter. In an appendix it is shown, by means of a criterion due to L. F. Richardson, that an inversion can only exist at a very small angle with the horizontal without becoming increasingly turbulent, a conclusion which is confirmed by observation. In a developing cyclone, the slope of the surface of separation between the cold and warm masses is of the order of 1 in 50, and the inversion is inevitably destroyed by mixing.—Miss L. F. **Lewis**: The effect of the source of air on its temperature at 4000 feet and 10,000 feet. During the winter months, the chief factor in determining the temperature of the air up to 2000 feet is its passage over a large expanse of land or sea. Air from the Continent is cold, while air from the Atlantic is relatively warm. On the Atlantic, however, some polar effect is shown when the path of the air is followed back for two days or more. At 4000 and 10,000 feet the chief factor is now the north to south component of the air's path, while the land and sea effect is small. Trajectories show that it is the latitude of the air two days before or even longer that determines the temperature.—L. H. G. **Dines**: A simple electrical time-marking system for use with self-recording meteorological instruments. The simple system of synchronous electrical time-marking installed a few years ago at Valencia Observatory, Cahirciveen, Co. Kerry, is described. A central clock operating hourly and minute contacts in series closes an electrical circuit once an hour. The circuit includes electro-magnets acting on suitable portions of the recording mechanism of the self-recording instruments which it is desired to include in the scheme. By this means time marks are easily obtained to an accuracy of a second or less.

Linnean Society, June 19.—Dr. A. B. Rendle, president, in the chair.—C. E. **Salmon**: A hybrid between *Carex remota* and *C. divulsa*. This occurred near Mayfield, in Sussex, in one large clump with a quantity of *C. remota* and a little *C. divulsa*. It differs from *C. remota* by its more scabrous stem, only one (or at most two) bracts, spikelets male at the summit, or even wholly male, and in other particulars. *C. remota* × *divulsa* seems extremely uncommon and is perhaps new.—T. A. **Dymes**: The seed of *Orchis latifolia*. The seeds of the British Dactylorchids fall into two groups: (1) Maculatæ, and (2) Latifoliæ. A form, agreeing in other respects with *O. latifolia* L., the seeds of which are obviously pure, has been found. The seeds belong to group (2) Latifoliæ, and are very like those of *O. prætermissa* Druce, and it seems probable that the two forms are close allies of the same species.—J. H. **Priestley** and Miss Lorna I. **Scott**: Leaf and stem anatomy of *Tradescantia fluminensis*

Vell. Vascular development in the leaf is first basifugal and afterwards basipetal, and the backward development of the subsidiary veins through the leaf sheath is associated with the subsequent development of the system of peripheral bundles, which lie in the sclerenchyma very near the periphery of the adult stem. Thus the functional vascular supply to the leaf passes through two stages in the stem. In the young internode, communication is maintained by means of the medullary and perimedullary bundles; as the growing internode extends in length the xylem of these bundles is disorganised, but at this time the peripheral bundles are differentiated throughout the internode and become functional.—T. B. **Blow**: Charophyta collected during a recent visit to Madagascar. These plants are interesting by reason of their affording a possible means of preventing the spread of malaria by acting as larvicides. The country covered was the east coast line, where are great marshes and much water, and where malaria is rampant, the higher ground around the capital, Tananarive, where the climate is much healthier, the mountainous portions near Antsirabe, where mosquitoes scarcely exist, and the district of the great Lake Alaotra, which is probably the most malarious part of Madagascar. It was noticed in connexion with several species of Chara that, where they abounded, there were rarely any mosquito larvæ in the water. The species that seemed to keep the water quite free of mosquito larvæ were as follows: *Chara Zeylanica, C. gymnopitys, Nitella Roxburghii*, and some other species of Nitella probably new.

DUBLIN.

Royal Dublin Society, May 27.—Prof. E. A. Werner in the chair.—W. R. G. **Atkins**: Notes on the filtration and other errors in the determination of the hydrogen ion concentration of the soil. As a general rule, the effect of increasing or decreasing the soil to water proportion, within limits, does not alter the P_H value by as much as 0·1 for soils between P_H 6 and P_H 8. With more acid or more alkaline soils larger alterations are thus caused. For lightly buffered acid soils one part of soil to two parts of water seems a safe proportion to adopt; for other soils a one to five proportion is convenient and, apparently, trustworthy. The P_H value of some soil extracts is markedly modified by filtration, even when a first filtrate is rejected. Both untreated and acid-extracted filter-papers may reduce the acidity. The use of large volumes, about 160 c.c., of filtrate, and a filter appropriate to the soil, reduces these errors: where possible, cleaning by the centrifuge is desirable. The fibres of acid-extracted papers act towards indicators as if as acid as P_H 4·8, but washing was not found to render them less acid. Unextracted papers are at about P_H 7·0-7·6, and give up traces of alkali to distilled water. The indicator brom-cresol green is to be preferred to methyl red for the same P_H range.—J. L. **McWhinney**: The soil fauna of a permanent pasture. A census of the invertebrate fauna resident on the surface, and in the soil to a depth of nine inches, of a permanent pasture forming part of the experimental farm of the Albert Agricultural College, Glasnevin, Co. Dublin, reveals a considerably greater density of population than has been found by other workers elsewhere. If the soil be dried before the count is made, numbers of the smaller species may be overlooked.

EDINBURGH.

Royal Society, June 2.—Prof. F. O. Bower, president, in the chair.—D. A. **Allan**: The igneous geology of the Burntisland district. Penetrating the Lower Carboniferous rocks of this area is a group of eleven volcanic necks, one of which is recorded for the first time. An examination of the boulders in the agglomerate has failed to produce material younger in age than the surrounding rocks. The lava flows comprise olivine basalts of the Dalmeny and Hillhouse types, together with a pyroxene-rich variety now designated as being of the Kinghorn type. From a consideration of the variation of the lavas, it has been possible to establish upon broad lines a series of zones. The intrusions include olivine basalts, teschenites, olivine dolerites, olivine-free dolerites, and quartz dolerites, the last named being probably the latest in development.—Ada M. **Malcolm**: The magnetic quality of very pure nickel. A nickel bar was examined by the magnetometric method (*a*) in a horizontal position, (*b*) in a vertical position, with and without an additional stress of ½ kgm. weight—the magnetising fields being of very low order. With the same bar in the horizontal position, complete hysteresis cycles were made, the field being increased in one case step by step, and in the other being continuously varied. The constant values of the susceptibility (K) and the permeability (μ) were calculated: $K = 4{\cdot}17$ to $4{\cdot}20$; $\mu = 53{\cdot}53$ to $53{\cdot}77$. A circular coil of nickel wire was also used, and its saturation point determined by means of a ballistic galvanometer. The graph tended to become straight in the neighbourhood of a field of 100 gauss. The purity of the nickel was not less than 98·5 per cent.—Winifred J. **Smith**: The law of recurrence and decay of after-images. The sequence of colours observed, after exposing the eye to white light for a given period, can be represented graphically by the combined effect of three exponentially decaying periodic curves, representing the sensations of red, of blue, and of green. Differential equations were derived from the curves chosen to represent the experimental results. The form of these differential equations suggests two different physical analogies, one to the interaction of three condensing electric circuits, and one to the motion of elastically connected masses.—H. **Briggs**: Apparatus to facilitate the use of an oxygen-carbon dioxide mixture on the treatment of carbon monoxide poisoning. The orthodox treatment by means of oxygen of a case of carbon monoxide poisoning is not especially effective, being apt to bring about sub-normal breathing at a time when the reverse is needed. Henderson and Haggard, of Yale University, have developed the method of treatment by oxygen plus 5 per cent. of carbon dioxide, a mixture which has not the same disadvantage. It stimulates breathing from the moment of application, and reduces the chance of serious sequelæ. The mixture is now obtainable commercially in America under the name of "carbogen." As carbogen cannot yet be bought in Great Britain, it was necessary to devise an apparatus to make it. The liquid carbon dioxide in a large-sized "Sparklet" bulb can be discharged into an oxygen cylinder of 290 litres capacity, the cylinder being then charged with oxygen to the standard pressure of 120 atmospheres. The mixture so made contains 5 per cent. carbon dioxide.—R. S. **Vaidyanathaswamy**: On mixed determinants. This paper deals with the extended determinants, containing suffixes of two different kinds (the "signants" and "non-signants" of Rice), and leads up to the concept of "inert suffixes" of matricular invariants, and the concept of "extensional invariants." Some features of the determinant-theory advanced are: (1) a new account of the "decomposition" of a determinant into determinants of lower dimensions, as a quoted development by linkage of "suffixes"; (2) a systematic use of "one-dimensional determinants"

as the ultimate entities of determinant-theory; (3) a new and improved version of the theory of multiplication of determinants.

PARIS.

Academy of Sciences, June 16.—M. Guillaume Bigourdan in the chair.—Louis **Gentil**: The structure of the *Dorsale Tunisienne*.—Charles **Richet** and Mme. A. **Le Ber**: The relation between the time of action and the concentration of a sterilising substance (hydrogen peroxide). In sterilising a culture with an antiseptic two factors intervene, the concentration of the antiseptic and the period of time during which it is allowed to act. Results of measurements of the minimum sterilising dose of hydrogen peroxide are given for times varying between 3 minutes and 15 hours.—E. **Leclainche** and H. **Vallée**: Symptomatic anthrax and gas gangrene in cattle. Clinical and bacteriological studies of *B. septicus* and *B. chauvœi*, and their pathological and immunising effects on cattle and horses.—A. **Desgrez**, H. **Bierry**, and L. **Lescœur**: A mode of differentiation of sulphurous waters.—Ch. **Depéret** and L. **Mayet**: Reply to the observations of S. Stefanescu on the phylogeny of elephants.—Jean **Effront**: The absorbing power of vegetable pulps.—Paul **Vuilemin**: Anomalies of leaves caused by alloplasy.—**de Montessus de Ballore**: The unsymmetrical curves of Gauss.—V. **Illavaty**: Remark on the quasi-asymptotic curves of Bompiani.—J. A. **Schouten**: The conformal and projective connexions of Cartan and the general linear connexion of König.—R. H. **Germay**: Application of the method of successive approximations to a lemma of Weierstrass and to its generalisation.—Georges J. **Rémoundos**: Couples of functions which satisfy an algebraic equation.—A. **Bloch**: The theorems of M. Valiron on integral functions, and the theory of uniformisation.—R. **Gosse**: Explicit integrals of equations of the first class, $S = f(x, y, z, p, q)$, which admit an intermediate integral of the first order.—André **Metz**: Concerning the geometry of a disc turning in a Galilean system.—C. **Kolossoff**: The torsion of prisms having a right-angled triangle as base.—A. **Gros**: Finite bending of a circular ring compressed diametrically.—J. **Seigle**: Some observations relating to the effects of permanent torsions on steels.—Louis **Roy**: Electrodynamical and electromagnetic induction in continuous media in motion.—Y. **Rocard**: Extension of some results of the kinetic theory of gases.—G. **Athanasiu**: The distribution of energy in the mercury arc spectrum. Measurements were made on three groups of lines, using a spectrometer with a quartz optical system, and a thermocouple for reading the energy of the radiations. The mercury arc lamp was maintained with a current of 3·75 amperes, the voltage varied between 30 and 80 volts. It was found that the energy curves of lines belonging to the same series had the same general shape. The ratio between the intensities of two lines of the same series remained practically constant when the energy consumed by the arc lamp varied between 100 and 300 watts.—Jean **Lecomte**: Quantitative studies on the infra-red absorption spectra of organic substances. In the infra-red region the opacities of the different substituting groups are not additive.—A. **Dauvillier**: Spectrographic researches on the A. H. Compton effect. The Compton effect only appears in the case where the selective absorption is very small, and it is far from having the generality predicted by the theory.—Max and Michel **Polonovski**: The derivatives of eserine obtained by hydrogenation.—Léon **Guillet**: The influence of the velocity of cooling on the properties of commercial aluminium. The mechanical properties and the electrical resistance of aluminium are modified by the velocity of cooling, at least, if the percentage of silicon is a little high. The properties of commercial tempered aluminium do not sensibly change on keeping.—K. v. d. **Grinten**: Adsorption and cataphoresis. An application of the method of electric transport observed with the ultramicroscope.—Sir William J. **Pope** and F. G. **Mann**: 1.2.3 triaminopropane. Its preparation; formation of complex metallic derivatives. The method of preparation of this triamine given by Curtius and Hesse is tedious and not without danger. The new method involves the following steps: citric acid, acetone dicarboxylic acid, di-isonitroso-acetone, diaminoacetone, diacetyldiaminoacetoxine, 1.2.3 triaminopropane. The yields are good throughout, and with the base thus obtained the complex cobalt and rhodium compounds $[Co(NH_2 . CH_2 . CH(NH_2) . CH_2NH_2)_2]Cl_3$ and $[Rh(NH_2 . CH_2 . CH(NH_2) . CH_2NH_2)_2]Cl_2$ have been prepared. The stereo-chemical study of this new type of metallic complex is being carried out.—Marcel **Delépine**: The origin of fenchol in the reaction of Bouchardat and Lafont. Turpentine treated with either mineral acids or organic acids always gives a mixture of borneol and fenchol esters.—C. **Vournazos**: The formation of the bismuthamines.—H. **Gault** and Y. **Altchidjian**: The dissociation of hexadecene at high temperatures.—R. **Locquin** and L. **Leers**: The dehydration of some new pinacones. Starting with the pinacones $R(CH_3) . C(OH) . C(OH) . (CH_3)_2$, hydration by Meerwein's method yielded the ketones $R(CH_3)_2 . C . CO . CH_3$ (R being normal propyl, butyl, or amyl) with no indication of the presence of the isomeric $(CH_3)_3 . C . CO . R$. Ketones of the latter type were prepared by another method for the purpose of comparison.—E. **Raymond** and G. **Clot**: The acetyl index of fatty materials. The method proposed is based on the volume of methane produced by the action of magnesium methyl iodide in anisol solution on the dried fat, with correction for fatty acid present.—P. **Lebeau** and J. **Marmasse**: The quantity and nature of the gases evolved by solid combustibles under the action of heat and a vacuum: lignites.—L. **Cayeux**: The felspathic grits of the Hercynian Chain and the products of Permo-Triassic evaporation.—Gaston **Astre**: The tectonic units of the Sierras del Cadi, of Port del Compte and of some adjacent massifs (Catalanian Pyrenees).—M. de **Lamothe**: The tectonic evolution of the relief of the southern Vosges during the Quaternary, and solution of the problem of Noir-Gueux.—Ch. **Mourain**, E. **Salles**, and G. **Gibault**: The value and variations of the terrestrial field at Val-Joyeux, near Paris. Curves summarising results obtained with the self-recording apparatus installed at the Val-Joyeux Observatory, showing the annual variation of the terrestrial electric field as a function of the period of the year, and also of the time of day.—E. **Bauer**, A. **Danjon**, and Jean **Langevin**: Crepuscular phenomena on Mont Blanc.—W. **Kopaczewski** and M. **Bem**: The electrical conductivity of mineral waters as a means of their control.—H. **Colin**: The sugar beet and the forage beet.—Mme. B. **Brilliant**: The water content in leaves and assimilating power.—Fernando de **Buen**: The biology of the sardine in Galicia (Spain).—Louis **Fage**: A new type of Mysidacea in the subterranean waters of the island of Zanzibar.—André **Leroy**: The transparency of the shells of hen's eggs, and the modifications which it undergoes with time.—Ch. **Pérard**: Researches on the coccidia and coccidoses of the rabbit.—T. **Mutermilch**: The nature of the heterologue hæmolysins (Forssmann).—N. **Ishimori** and T. **Metalnikov**: The immunisation of the caterpillar of *Galleria melonella* by non-specific substances.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 10, No. 5, May).—E. **Tomanek** and E. B. **Wilson**: Is pneumonia increasing? Statistics have been gathered of all forms of pneumonia in the United States registration area for the period 1900–1920. Making due allowances for the increase of registration area during that period, for the changed standard of life and economic conditions, and for difficulties of diagnosis, it is inferred that the disease is neither increasing nor decreasing.—G. A. **Miller**: Prime power substitution groups whose conjugate cycles are commutative.—R. L. **Moore**: (1) An extension of the theorem that no countable point set is perfect. (2) Concerning the prime parts of certain continua which separate the plane.—J. R. **Kline**: Concerning the division of the plane by continua.—F. B. **Sumner**: The partial genetic independence in size of the various parts of the body. Castle's figures for the correlation between total size and the size of individual organs or members are calculated from data from a "mixed population." Much lower correlations are obtained if sets of calculations are confined to a single race.—W. E. **Castle**: Are the various parts of the body genetically independent in size? A reply to the preceding paper. The calculations were based on a "mixed population" deliberately. It was sought to discover whether with change in general body size through genetic (not environmental) agencies there was a corresponding change in different parts of the body; hence it was desirable to start with differences in body size as great as possible.—L. L. **Woodruff** and E. L. **Moore**: On the longevity of *Spathidium spathula* without endomixis or conjugation. This organism was cultured by daily isolation in standard beef extract for 444 days, after which the animals suddenly appeared abnormal and died. The graph giving the average daily rate of division of the four lines of culture used shows only such fluctuations as may readily be accounted for by external factors. Pedigree cultures of *S. spathula* have shown progressive lengthening of life without endomixis or conjugation, and it is now considered that the organism can reproduce indefinitely in this way, given suitable environment.—D. L. **Webster**: A possible explanation of tertiary line spectra in X-rays. Objection is raised to the hypothesis of Clark and Duane on the grounds that the energy of the tertiary beam would be very small and that the narrow peak observed in the ionisation curve cannot result from reduction by filtering on emergence from the radiator of a continuous spectrum. It appears more probable that the atoms ejecting the photo-electrons are the source of the radiations. Data from the spectra of thin targets are in general agreement with this hypothesis.—G. L. **Clark** and W. **Duane**: On the theory of the tertiary radiation produced by impacts of photo-electrons. The short wave-length limits and the angles corresponding to them, calculated from Webster's theory, are not in accord with experimental and theoretical results obtained by Clark and Duane except for elements of low atomic number. This is to be expected since the difference between the theories resolves itself into a difference, which increases rapidly with the atomic number of the element, between a critical absorption frequency and that of a given emission line. Clark and Duane's theory also offers an explanation of the radiation found by de Broglie on the long wave-length side of radiations from a tungsten-carbon target.—S. K. **Allison** and W. **Duane**: Absorption measurements of certain changes in the average wave-length of tertiary X-rays. The "hump" of tertiary radiation in Clark and Duane's experiments shifts towar longer wave-length with increase in the angle betwe the primary and secondary X-rays. Using t secondary radiation of maximum intensity a employing a polished silver plate as seconda radiator, the effects of tellurium, antimony a iodine screens were investigated. An apprecial quantity of radiation shifts over to longer wa lengths at angles greater than 40°.—I. S. **Bow** and R. A. **Millikan**: The series spectra of the stripp boron atom (B III.). All the lines which, fr theoretical considerations, can be expected in a strength from a boron atom deprived of all valer electrons, have been identified. Lines hitherto r identified or now discovered occur at λλ 4499·0 2077·79 A; another line at 677·1 A is shown to doublet with a separation of 0·15 A (correct to least 0·01 A) or in frequencies, of 32·7 cm.$^{-1}$. T line at 758·5 A is the first term of the sharp ser of B III.

Official Publications Received.

Mellon Institute of Industrial Research of the University of Pittsbu Industrial Fellowships. Pp. viii+21. (Pittsburgh, Pa.)

Bulletin of the National Research Council. Vol. 8, Part 2, No. 44: Continental Shelf off the Coast of California. By Andrew C. Laws Pp. 23. (Washington, D.C.: National Academy of Sciences.) 25 cent

Fourth International Congress of Refrigeration, London, June 1 First International Commission of the International Institute of frigeration. Reports and Communications presented by the Presid H. Kamerlingh Onnes. Pp. viii+257. (Leiden: Edouard Ijdo.)

Smithsonian Institution: United States National Museum. Contri tions from the United States National Herbarium, Vol. 22, Part 8: American Asteraceæ. By S. F. Blake. Pp. xi+587-661+plates 54 (Washington: Government Printing Office.) 20 cents.

Meddelanden från Statens Skogsförsöksanstalt. Hälfte 21, No. 1: Bidrag till Kannedomen om Brunjords- eller Mulljordstypens Eg kaper och Degeneration i södra Sverige; ein Beitrag zur Kenntnis Eigenschaften und der Degeneration der Bodenarten vom Braunerdety im südlichen Schweden. Av Karl Lundblad. Pp. 48. Hälfte 21, No Den å Böda Kronopark utförda Grönkvistningen av Tall; die Aufast an Kiefer im Staatsforst Böda. Av Erik Lundh. Pp. 49-100. Hälfte No. 3: Om våra Främmande Barrträds Vinterhärdighet; über Winterfestigkeit fremder Nadelbäume in Schweden. Av Nils Syl Pp. 101-148. (Stockholm.)

Transactions of the Optical Society. Vol. 25, No. 3. Pp. 97- (London: Imperial College of Science.) 10s.

University of Illinois Engineering Experiment Station. Bulletin 140: The Viscosities and Surface Tensions of the Soda-Lime-Silica Gla at High Temperatures. Part 1: The Viscosity of Glass at High Temp tures. By Prof. Edward W. Washburn and George Reed Shelt Part 2: Surface Tensions of Glasses at High Temperatures. By P Edward W. Washburn and Earl E. Libman. Pp. 74. (Urbana, 45 cents.

The National Physical Laboratory. Report for the Year 1 (Published for the Department of Scientific and Industrial Resear Pp. 228. (London: H.M. Stationery Office.) 13s. 6d. net.

Ministry of Agriculture, Egypt: Technical and Scientific Serv Bulletin No. 44: The Propagation and Cultivation of Citrus Trees Egypt. By Thos. W. Brown. Pp. vi+88+30 plates. Bulletin No. The Insect Pests of Citrus Trees in Egypt. By W. J. Hall. Pp. iv+ (Cairo: Government Publications Office.) 5 P.T. each.

Reprint and Circular Series of the National Research Council. No. Statement of Activities of the National Research Council for the Y July 1, 1922–June 30, 1923. By Vernon Kellogg. Pp. 16. 25 ce No. 51: The Higher Agricultural Education of the Future. By Marchal. Pp. 6. 20 cents. No. 52: The Specific Heat and Ther Diffusivities of certain Explosives. By A. M. Prentiss. Pp. 44. 25 ce No. 53: A List of Research Problems in Chemistry. By J. E. Zane Pp. 9. 15 cents. (Washington, D.C.: National Academy of Sciences.)

Trinidad and Tobago: Council Paper No. 15 of 1924. Agricultu Credit Societies: Report by the Registrar of Agricultural Credit Socie for the Years 1922 and 1923. Pp. 12. (Port-of-Spain: Governm Printing Office.) 6d.

Department of the Interior, Canada. Publications of the Domin Astrophysical Observatory, Victoria, B.C. Vol. 2, No. 15: Evidence the Bending of the Rays of Light on passing the Sun, obtained by Canadian Expedition to observe the Australian Eclipse. By C. Chant and R. K. Young. Pp. 275-287. (Ottawa: F. A. Acland.)

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Proceedings of the Edinburgh Mathematical Society. Vol. 42 (Sess 1923-24), Part 1, April. Edited by Dr. Archibald Milne and Dr. T. MacRobert. Pp. 59. (London: G. Bell and Sons, Ltd.) 5s. net.

Third Report of the Hayling Mosquito Control, May 1923 to May 1 Pp. 12. (South Hayling: J. F. Marshall, Hon. Director, Seacourt.)

Report of the Director of the Royal Observatory, Hongkong, for Year 1923. Pp. 18. (Hongkong.)

NATURE

SATURDAY, JULY 26, 1924.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2856, VOL. 114]

Applied Chemistry in Peace and War.

In a recent issue of the official organ of the Society of Dyers and Colourists,[1] Prof. Gardner reviews impartially and judicially the present position of the British dyestuffs industry, more especially with regard to recent negotiations between the British Dyestuffs Corporation Ltd. (B.D.C.) and the Interessen-Gemeinschaft (I.G.). His article, which is written in non-technical language, should be read by all wishing to obtain a clear perspective of the dyestuffs problem in its national aspects.

It is essential in considering the merits and demerits of the proposed agreement to differentiate clearly between the British dyestuff industry and the B.D.C., a distinction which is daily becoming more pronounced in proportion as the independent dyemakers gain an increasing amount of the home trade in colours. An agreement which is mutually advantageous to the I.G. and the B.D.C. may nevertheless be ruinous to the British competitors of the latter organisation. A criticism frequently made against the recent report of the Dyestuffs Development Committee of the Board of Trade is, that this document emphasises the great technical advances made since the War by British colour chemists, and at the same time urges the need for a continuance of the protection afforded to the industry by the Dyestuffs Act. The two points of view are, however, not inconsistent.

The enormous improvement in manufacturing capacity cannot be gainsaid. It may be recalled that prior to the War, 80 per cent. of British requirements for dyes came from abroad, and principally from Germany; at present "something over 80 per cent." of our home needs are supplied by British makers. It is, however, to secure the remaining 16 per cent. that the directors of the B.D.C. are striving for an arrangement with the great German combine. It is argued, Why should we expend money on research when the results are ours for the asking? Not being chemists, the directorate forgets that there is no finality in chemical industry, and that even now investigations are on foot which may render obsolete many of these precious dyes and also the majority of the commoner ones. To ensure steady growth, the still infantile industry needs protection not only from competition outside but also from apathy and lack of knowledge within the nation.

At the same time, it should be conceded that, so far as the interests of his shareholders are concerned, the chairman of the B.D.C. has done a great work in internal reorganisation and retrenchment, and also, in

[1] W. M. Gardner, "The British Dyestuffs Industry," Journal of the Society of Dyers and Colourists, vol. 40, No. 6, June 1924. (Bradford: Pearl Assurance Buildings, Market Street, 1924.) 5s.

view of the possible repeal of the Dyestuffs Act, he has made a very good bargain with a foreign competitor against whom the home industry would be heavily handicapped if the existing restriction on foreign importation were removed.

While these acute discussions are in progress in Great Britain, five lectures delivered by Prof. Haber during the last four years, and recently published,[2] have the sombre significance of the writing on the wall, for the text of his discourses may be taken to be the national necessity of a self-contained chemical industry vital to the public welfare either in peace or war. As the recipient of a Nobel Prize, the lecturer naturally dealt with the more peaceful attributes of the industrial synthesis of ammonia from its elements. But the warlike aspects of chemical science are displayed in the address on "Chemistry in War," delivered to the officers of the Ministry of National Defence (1920), and in the lecture on "The History of Gas Warfare," given last October before the Parliamentary research committee of the German Reichstag. In the former discourse Haber refers to the larger problems of munitions which arose in Germany on the prolongation of the War, and also on the special requirements for chemical warfare. He compares favourably the comparatively humane nature of the casualties inflicted by chemical means with the ghastly and disfiguring wounds produced by flying shrapnel and the other older weapons, and points out that, in spite of the Washington Conference, the fervent wish expressed in England, as in America, for the establishment of an independent chemical industry is due to a recognition of the importance of this trade in the production of chemical munitions of war.

In the lecture to the Reichstag representatives, Prof. Haber traces the development of chemical warfare both before and since the surprise attack with chlorine made by the German army at Langemark on April 22, 1915. He concludes by asserting that the moral indignation displayed in the Entente press during the War was directed principally against German gas warfare, but not against the employment of similar weapons by the Allies.

It is doubtful whether the proposed agreement between the B.D.C. and the I.G. will restrict secret preparations for gas warfare being made by any nation holding a predominant and self-contained position as regards the chemical arts. Our path of safety is to encourage to the utmost the development of research and industrial expansion in an independent national dye industry. G. T. M.

[2] "Fünf Vorträge aus den Jahren 1920-1923: Über die Darstellung des Ammoniaks aus Stickstoff und Wasserstoff; Die Chemie im Kriege; Das Zeitalter der Chemie; Neue Arbeitsweisen; Zur Geschichte des Gaskrieges." Von Fritz Haber. Pp. v+92. (Berlin: Julius Springer, 1924.) 0·65 dollar.

Sir Archibald Geikie.

A Long Life's Work: an Autobiography. By Sir Archibald Geikie. Pp. xii+426. (London: Macmillan and Co., Ltd., 1924.) 18*s.* net.

FROM time to time Sir Archibald Geikie has interested his numerous readers by writing sketches or reminiscences of incidents in his long and busy life. In the volume now before us he has set out in orderly sequence the principal events of his career from early boyhood to a well-earned period of rest. Advancing years may have curtailed his activities, but his memories of friendly intercourse with many distinguished men in all parts of the world, of the almost innumerable functions in which he has taken a prominent part, and the charm of the literary style in which he tells his experiences, remain as fresh as ever.

Born in 1835, Geikie's earliest reminiscences relate to incidents which to many of us seem to belong to ancient history, as, for example, the gathering of the Elders at the Disruption of the Kirk of Scotland, when black coats swarmed like hiving bees in and out of St. Andrew's Church, or the opening of the first railway in Scotland. But interest centres chiefly on the early proclivities of the boy himself, inasmuch as he was destined to become a leader in geology, a noted man of letters and a distinguished public servant.

At the Edinburgh High School, Geikie acquired an appreciation of the Latin classics which has been a joy to him all his life, but a love of Nature was evidenced by a passion for collecting butterflies. It was while so engaged in a limestone-quarry that he first found a fossil. Enthusiastically he broke up block after block, disclosing delicately preserved plants, and realising, not without awe, that he was bringing to the light organisms that had never before been seen by human eyes. Thenceforward the rocks and their fossils became increasingly the subject of his thoughts. Through this incident he became acquainted with Robert Chambers, author (as it appeared later on) of "Vestiges of the Natural History of Creation." He read every book on geology he could lay hands on, but in the "Old Red Sandstone" of Hugh Miller found a greater stimulus than in any other, not so much from the information it supplied as from its revelation of the enthusiasm of a true lover of Nature. From the consideration he received at the age of seventeen from such men as Logan, David Forbes, and Sorby, it may be inferred that he had already shown unusual promise as a geologist.

The time had come, however, for choosing a profession, and to his parents, as to so many others before and since, it appeared that though geology might be

a pleasant pastime, it could scarcely provide a living. They decided therefore to put young Geikie into a bank after two years' instruction in law in the office of a Writer to the Signet. The work proved to be "unspeakably dull," and the two years' training was never completed.

During a holiday in London Geikie returned to his old love. He passed many happy and profitable hours in the galleries of the newly established Geological Museum in Jermyn Street, and about this time (1853) first heard of the Geological Survey, a branch of the public service which had been initiated by De la Beche some ten years before. An interview with Sir Andrew Ramsay, at that time local director, and a walk taken over Arthur's Seat at Ramsay's invitation (issued, as we may suppose, for the purpose of forming an opinion of the young geologist's capability), led to a suggestion that a post on the survey might be found. In the interval of waiting he wasted no time. Some geological work in Skye formed the basis of a communication to the Royal Physical Society of Edinburgh in 1854, his first appearance before a learned society. Determined to continue his literary studies, he matriculated at the University of Edinburgh as a student of the humanities, and though prevented by domestic circumstances from completing the course, he became one of the best scholars of his year and the best writer of English prose and verse. In 1855 he obtained a post on the Geological Survey, and commenced his long career as a professional geologist. Let it be well taken to heart that he had equipped himself not only as a geologist, but also as a scholar and man of letters.

In the next few pages Geikie describes the work of a field-geologist, the simple accoutrement required, and the difficulty country people felt in understanding how he could tell what lay below the surface of the ground without digging. The work was arduous, and according to official regulations occupied nine hours a day, in practice probably much more. He found time and energy, nevertheless, to pursue his classical studies, and even enlivened long tramps home by recitations from his favourite poems. "I look back," he says, "on this period of my life as perhaps the most studious and certainly one of the most delightful that I have been privileged to enjoy." New discoveries in geology quickly followed, notwithstanding MacCulloch's vainglorious boast that he had left nothing in the geology of Scotland that could not have been effected by a surveyor's drudge or a Scottish quarryman. A fossiliferous shale was detected under massive sheets of Old Red Sandstone lava, but the origin and age of igneous rocks began to take first place in Geikie's attentions. In touching upon such questions he conveys his information in language which is intelligible to non-scientific readers; modern scientific technicalities find no place in these pages, when good English serves. For some time Geikie was the sole representative of the Geological Survey in Scotland. On him alone lay the responsibility of mapping a region extending into several counties and calling for much sagacity in dealing with new problems.

In 1860, owing to the death of Prof. George Wilson, who had had it in hand, it fell to Geikie to complete the "Life of Edward Forbes." Some hesitation was felt in entrusting the work to so young a man, but the book was completed and published in 1861, forming the first of a number of charming biographies from the same pen. In the autumn of 1860, Geikie accompanied Murchison on a tour through the Highlands, and though the secret of the Highlands was not yet to be told, his accounts of the hospitalities extended by the many large landowners with whom Murchison was acquainted, make good reading. In the winter, Ramsay having been taken ill, Geikie was called upon to take over the lectures at the Royal School of Mines and the popular geological addresses to working men in the theatre of the Jermyn Street museum. These addresses were delivered by the most eminent men of the day on their respective subjects and were attended by crowded and intelligent audiences. I have myself seen the theatre full of working men listening spellbound to an exposition by Huxley of the elements of biology.

The relics of the Glacial Period, during which a large part of the British Isles was overridden by ice-sheets, now began to claim Geikie's attention. Boulder clays, sands and gravels, collectively known as "glacial drift," were spread over the country during this period in such quantity as to dominate the soil and often completely to mask the characters of the underlying "solid" formations. A holiday spent in quest of glacial drift led to a communication to the Geological Society of Glasgow in which Geikie reviewed the sequence of events in Scotland and showed the boulder-clay to be the product of an ice-sheet, and not, as was stoutly maintained by many, of floating ice. He obtained confirmation of this view by an exploration of northern Norway.

By this time Geikie's intimate knowledge of a large part of his native country, his appreciation of a landscape, and the geological training by which he was enabled to interpret the significance of the features of the ground, impelled him to the writing of "The Scenery of Scotland." The book, though in direct antagonism to Murchison's cataclysmic opinions, was dedicated to him. The compliment was accepted without demur.

In 1867 a separate branch of the Geological Survey was constituted for Scotland and Geikie was appointed

director. Suitable men for the posts on the new branch were scarce, and among the candidates one at least, who afterwards achieved a great reputation as a geologist, and was in fact an able algebraist, failed to add up correctly against time long columns of pounds, shillings, and pence, a test of the capability of a field-geologist which was insisted on then and for many years afterwards by the Civil Service Commissioners. Friendships with many eminent literary and scientific men continued to ripen. Alexander Macmillan was one of the earliest and most constant. Another old friend, Poulett-Scrope, a high authority on volcanic problems, being desirous that the volcanic regions of southern Italy should be examined by a competent geologist, contributed two hundred pounds for the expenses and suggested to Geikie that he should undertake the examination. The offer was accepted, but a severe fever, developed at Lipari, put an end to the project.

Provision for a chair of geology in the University of Edinburgh having been made by Murchison in his will, he desired to nominate Geikie as the first professor. The Home Office objected to this as an interference with the prerogative of the Crown, and the Science and Art Department objected to two posts being held simultaneously by the same man. The objections were, however, overcome, mainly through the influence of Lyon Playfair, Member of Parliament for the University, and Geikie was appointed in 1871. In this same year he married and travelled to the south of France to visit his wife's relatives, witnessing on the way some of the horrors of a successful Prussian invasion. He was summoned back to the deathbed of his old chief and friend, Sir Roderick Murchison.

The creation of a school of geology in a poorly endowed University was beset with difficulties; lecture-rooms were inadequate, and rocks and fossils were lacking. The exceptional advantages for field-work offered by the country round Edinburgh were therefore utilised to the full. The field took the place of a lecture-room, and Nature supplied the specimens. In his second year the professor lectured to the Ladies' Educational Association and conducted geological excursions of ladies. Mixed classes, however, were not yet tolerated, and the male students were returned to their homes before the ladies appeared, a mistake in the opinion of the good lady who kept the inn where they stayed. Later, he lectured to the lunatics at the Morningside Asylum, and, by the help of an official, to the inmates of a Deaf and Dumb Institution.

These varied activities were not allowed to interfere with literary work. The third edition of Jukes's "Student's Manual of Geology" was completed by Geikie in 1871; in 1873 two science primers were written, and "The Life of Murchison" was in hand. In the same year, also, obituary notices of two old and valued friends, Logan and Lyell, were gratefully undertaken. At this time, what was perhaps the most onerous task in a busy life began to occupy his mind, namely, the preparation of an advanced text-book of geology. This work, a monument of research, of matured judgments and of lucid statement, was published in 1882. It is interesting to hear that the author of such a work found the writing of the little primers the most difficult task he had ever undertaken. The preparation of a classic memoir on the Old Red Sandstone, and a study of the weathering of marble and other rocks, as evidenced by tombstones, helped to consume what surplus energy was left after the performance of official duties.

An engagement to lecture to the Lowell Institution in Boston in 1879 led to an extended tour in the United States, in the course of which the Yellowstone Park and Salt Lake City were visited. While at Boston Geikie dined at Lowell's house and sat between Longfellow and Oliver W. Holmes. The poet's face "always beamed with a kindly smile," but to talk to him proved difficult.

In 1882 Geikie succeeded Ramsay as Director General of the Geological Survey and resigned his Edinburgh professorship. His new duties included supervision of the Scottish and Irish branches, the latter no sinecure, when one member of the staff, still well remembered, was on the warpath. Yet now as ever, time was found for literary work. The text-book was not yet published, and "Geological Sketches at Home and Abroad" was in preparation. At the same time he was prosecuting his studies of British Tertiary volcanic history, the results of which were published by the Royal Society of Edinburgh and were afterwards embodied in "Ancient Volcanoes of Great Britain."

The next few years saw no relaxation in this strenuous life. He was elected foreign secretary of the Royal Society in 1889, but undertook a more onerous task as president of the Geological Society in 1891–92. Presidentship of the British Association followed soon after, and among a shower of press clippings with which the occupant of such a post is bombarded, was one from a phrenological journal to the effect that the "organisation of this gentleman is most favourable for almost any sphere of life." The prophet was on safe ground, for, in addition to the posts already mentioned, Geikie was a member of the Royal Commission on Water Supply and of the Departmental Committee on the Ordnance Survey.

Among much other literary work now in hand was a biography of Sir Andrew Ramsay, the late Director-

General. In lighter vein were the dinners of the Literary Club. At these monthly gatherings Geikie met many distinguished men of letters and retailed the latest good stories from Scotland. The appearance of some of these in *Punch* puzzled him for a time, but he eventually detected the route by which they had travelled. A few years later in "Scottish Reminiscences" he published a selection of (but not all) his experiences of Scottish manners, customs and speech.

A visit was paid to Paris in 1891 to attend the centenary of the Institut de France. The guests were received at an evening function by M. Poincaré, then in his thirty-fifth year. Six years afterwards Geikie received through the French Embassy a beautiful specimen of Sèvres ware, but it was not until some months had elapsed that the unexpected gift was explained. Prof. Fouqué and M. Michel Lévy had moved their Government to accord Geikie the decoration of the Legion of Honour. But the French Ambassador pointed out that the British Government did not approve of the acceptance of foreign decorations by British subjects. The china had therefore been sent as a public mark of esteem, with an expression of keen regret that the British Government should be so exclusive. However, sixteen years later the Cross of the Legion of Honour reached its destination.

The International Geological Congress met every third year before the War, and in 1897 assembled at St. Petersburg. There Geikie was presented with other delegates to the Czar and Czarina and saw a charming phase of Russian home life in the country palace of the Dukes George and Michel of Mecklenburg.

The long period of service upon the Geological Survey was now drawing to a close. In the view of the Treasury, the service itself was of a temporary character and would cease to exist when a geological map of the British Isles on the scale of one inch to the mile had been completed. In such circumstances there had been a tendency to shelve questions relating to promotion, salaries and other matters, about which much dissatisfaction had arisen. This led to a request from the staff for a full inquiry, and eventually to the appointment of a strong committee, on which Government Departments, geological and mining interests were adequately represented. The recommendations made by the Committee were eminently practical and satisfactory. "It was to me," Geikie writes, "a great satisfaction to leave the service with the prospect that these much-needed reforms would be carried out." He retired in 1901 after a service of forty-four years and four months.

Abrupt severance from official duties is apt to leave a man at a loose end, but it was far otherwise with Geikie. Some Survey memoirs were still in hand, and various scientific societies made claims upon his time. Attendance at the first meeting of the International Association of Academies took him to Paris, and at the 450th anniversary of the University of Glasgow he was one of the recipients of the honorary degree of LL.D. In the winter of 1902–3 he attended meetings of the Reale Accademia dei Lincei, of which he was a foreign member, unaware that he was thereby earning a small fee for each attendance. In 1903, at the ninth meeting of the International Geological Congress, in Vienna, he renewed intercourse with his old friend Suess and many others. In this year also he was elected one of the general secretaries of the Royal Society, a post which involves much work in connexion with the numerous activities of the Society. Outside the ordinary routine was the making of arrangements in London for the second meeting of the International Association of Academies. The functions provided for the entertainment of the guests included a garden-party at Windsor Castle, when the members were received by King Edward and Queen Alexandra. The first centenary of the Geological Society was celebrated in 1907. It being felt that the presidential chair should be filled on such an occasion by a geologist of outstanding reputation, Geikie, though he had already been president, was asked to allow himself to be nominated. The celebration led to what was probably as distinguished an assemblage of geologists from all parts of the world as had ever met.

In 1908, on the retirement of Lord Rayleigh, the Council of the Royal Society nominated Geikie as his successor to the presidential chair. The many duties which are attached to the post, both within the Society's rooms and outside, made serious inroads upon his time, but gave him the opportunity of devoting his energies more strenuously than ever to the welfare of the Society. The most outstanding incident during his presidentship was the celebration of the 250th anniversary in 1912. Men distinguished in every branch of science attended from all parts of the world. After a short service in Westminster Abbey, the delegates handed the addresses with which they had been entrusted to the president in the Society's Library. In the evening a banquet was held in the Guildhall, at which the toast of the Royal Society was given by the Prime Minister and responded to by the president. An unpremeditated toast was added to the list during dinner, that of Prince Lichnowsky, the newly appointed German Ambassador. In his reply he said, "Never between England and Germany have there been more intimate and more sincere relations than at present. Both countries are working side by side in the same cause of maintaining European peace." It appears to have been a fact that the preparations for the War, then

being made by the higher powers in Germany, were not known to the German Ambassador. Two notable volumes were prepared at Geikie's instance in readiness for the celebration; one an enlarged edition of the Society's "Record," the other a facsimile reproduction of the Charter Book containing the original signature of Charles II., followed by the signatures of all fellows from the commencement, "a collection of autographs probably without an equal, as representative of the science and culture of Europe during the period which it embraces."

At this time the British Academy came into existence and was soon followed by the Classical Association. As president of the latter Geikie chose for the subject of his address the evidence in Latin literature of an appreciation of Nature by the Romans. The subject proved so fascinating that he pursued it later on both at home and amidst landscapes that must have been familiar to some of the Roman poets. The writing of the book, "The Love of Nature among the Romans," served, so far as anything could, to distract his thoughts from the tragedy of the death of his only son, a young man of brilliant promise.

From 1914 Geikie's time has been spent chiefly at his country home near Haslemere, and though not so active as he once was, there has been little relaxation in his industry. In 1920 he was elected as chairman of the Royal Commission of Inquiry into the University of Dublin. "The Annals of the Royal Society Club" was written during these years of retirement, and now has been followed by the fascinating volume to which this notice relates. It was during this period of quiet retreat, on the last day of 1913, that a special messenger brought the intimation that the King had conferred upon Geikie the Order of Merit. He had already been made K.C.B. in 1907. Space does not admit of the enumeration of the academic honours conferred upon him.

I cannot conclude more fittingly than in the words used by Walter H. Page, at the time American Ambassador. In a letter to Geikie on his birthday, which he had learnt was the same day as that of the President of the United States, he wrote, "You also are entitled to great thanks for being born into a world that you have made wiser and merrier by your presence and labour."

A. STRAHAN.

A Biological Study of Radiation.

Radium, X-rays and the Living Cell: with Physical Introduction. By Hector A. Colwell and Prof. Sidney Russ. Second edition, revised. Pp. xi+365 +3 plates. (London: G. Bell and Sons, Ltd., 1924.) 21*s.* net.

THE second edition of this book, which was first published nine years ago, brings the experimental biological study of the effects of radiations up-to-date; it includes a new chapter which summarises the action of rays on living structures, and discusses the theories put forward to explain these actions.

The authors are, rightly, cautious in discussing "Laws." Their subject is a new one, and it is only recently that the nature of X- and gamma rays has been settled and their place in the electromagnetic spectrum charted.

How do X-ray exposures cure tuberculous glands? By killing the tubercle bacilli? In a test-tube, X-rays can kill tubercle bacilli, but it takes a big dose—so big that no human tissues could live through the bombardment. How then does a moderate dose cure the patient? Clearly it is the human body that achieves the cure; the tissues react to the radiation, and kill and rid themselves of the intruding bacilli, weakened by the radiation. Many factors may be at work. The action of the X-rays may be selective, weakening the bacilli but weakening the tissue cells less, or actually stimulating the tissue cells to increased activity.

Clearly there are countless problems for experimental solution. The conclusions so far reached are valuable but (as the authors point out) they are still very incomplete, inconclusive, and even contradictory.

Of chief interest is the bearing of these researches on the treatment of cancerous growth. Stated briefly the conclusions are: Some growths can be abolished and an apparent cure obtained. Others can be reduced in size, with temporary relief, only to take on new activity which defies control by radiation. Even the "cures" are only too commonly illusory. The disease breaks out again in the same place or elsewhere and becomes disseminated. We seem to be no nearer the "cure" for cancer. But we need not despair, nay, we dare not. Although a cure may never be found, there is great hope of our learning how to prevent cancer. We are now certain that cancer is not a disease which springs upon us mysteriously, and strikes us down "like a bolt from the blue." It is the last phase of a chronic disease that affects our tissues, makes them unsound, and deprives them of their powers of resistance.

Certain races live a natural life in the open air engaged in active agricultural pursuits, and eating the natural "live" foods of Nature (grains, nuts, milk, eggs, fruits, and uncooked vegetables). These races are immune from the disorders of digestion so rife in civilised lands. They do not suffer from dyspepsia, gastric and duodenal ulcer, gall stones, appendicitis and colitis, and they live to a good age without falling victims to cancer. Contrast their state with that of dwellers in civilised towns. Their life is largely indoors and sedentary, their food and drink almost entirely "dead" food; it is frozen for long periods, or boiled and canned, or impregnated with chemicals, such as

borax, sodium salicylate, and saltpetre. Even the fresh foods that reach the consumer un-killed and undefiled, pass through the kitchen, and are there deprived of their living properties, and worked up into appetising dishes. "Hunger is the best sauce," but the life that is forced upon civilised races deprives them of this relish. To make matters worse, sugar (sweetmeats and chocolates) are eaten in great quantity. The consequence is that the digestive system fails; constipation and intestinal stagnation occur; the overfilled stomach and intestines drop and become kinked; their stagnant contents decompose and poison the system. Not only the stomach and intestines, but also every tissue of the body is poisoned and loses its power of resistance. Sooner or later a stage is reached when some part gives way, when we have another case of gastric ulcer or appendicitis, and the surgeon is called in to remove the part that has "rotted." If the surgeon is an observer, he notices that the rot is general and is not confined to the appendix, gall bladder, or gastric ulcer which he is removing.

A person whose tissues are in this state is certainly on the road to cancer, and little lasting good can come of an attempt to cure him by local radiation. He must "clean himself up"; then Nature will have a chance to aid him in his fight for life. The great good that may come from the experimental researches described in this book is that it may teach us Nature's method of ridding itself of morbid growths. The new edition is of immense interest to all who are engaged in the study of tumour growth.

Our Bookshelf.

A Practical Handbook of British Birds. Edited by H. F. Witherby. 2 vols. Vol. 1. Pp. 532+xvi. Vol. 2. Pp. 960+xii. (London: H. F. and G. Witherby, 1919–1924.) 4*l.* 10*s.* net.

THIS important work, which has been appearing in parts since 1919, is now complete, and the corrections and additions in the last part bring the whole up-to-date. The bound book is available in alternative forms, and of these the thin paper edition makes two volumes of little more than pocket size. It is thus a handbook in a real sense, but at the same time the quality of its contents fully entitles it to a worthy place on the library shelf with larger works of reference.

The object aimed at has been to give in a small space and in systematic form all the most important information about the external characters of British birds, their distribution and migration, their breeding habits, nests and eggs, their song and their food. This has been very successfully achieved by the authors responsible for the various subjects. The numerous illustrations, many of them in colour, are admirable from the point of view of practical utility as aids to identification. There are also useful key tables to the distinguishing characters of the different systematic groups.

The book is, however, more than a carefully compiled and well edited work of reference. It represents, indeed, much original investigation, the results of which are presented for the first time. This refers particularly to the descriptions of plumage, most of them by the editor himself, which constitute the most important part of the work. These descriptions have been based upon new examinations of large series of specimens, including those in the British Museum and in Lord Rothschild's large collection, and they take full account of all differences of sex and age and of all seasonal changes: the different geographical races or sub-species are separately treated. The method is consistently followed in this respect, and in a few cases, from their nature unimportant in British ornithology, a phase is frankly mentioned as "not examined." A great labour has obviously been performed, and as a result we have much valuable information not previously available, and a high trustworthy standard throughout.

The treatment of the other subjects is less detailed but quite adequate for the purpose, the limits observed being those proper to a condensed work of reference. The contributors, other than the editor, are Dr. Ernst Hartert, Miss A. C. Jackson (Mrs. Meinertzhagen), the Rev. F. C. R. Jourdain, Mr. C. Oldham, and Dr. N. F. Ticehurst.

This "Practical Handbook," then, in addition to containing important new contributions to ornithology, seems to us to be the most useful systematic text-book of British birds that can be placed in the hands of the serious student of the subject. It undoubtedly takes its place as a standard work.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of the Work done in Science, Literature, and Art during the Session 1922–1923 by numerous Societies and Government Institutions. Compiled from Official Sources. Fortieth Annual Issue. Pp. vii+389. (London: C. Griffin and Co., Ltd., 1923.) 15*s.* net.

WE are glad to be able to extend a welcome once more to this valuable handbook, which has now reached its fortieth anniversary. The publishers are to be congratulated on the courage and persistence with which they have issued year by year a volume so useful to all who would keep in touch with scientific developments and at the same time a book necessarily of limited circulation. The volume is divided into the customary fourteen sections, in each of which related societies are grouped. The classification this implies is a difficult problem, but we have little fault to find with the present arrangement; the Institute of Physics would appear more appropriately in the section given to astronomy, mathematics, and physics than in its present place under "Science Generally." The very full index, however, will generally obviate any difficulty which may arise in this way.

For those who are not familiar with the handbook, it is desirable to say that it gives full particulars of the scientific and learned societies of the British Isles, their officers, addresses, meetings, conditions of membership, publications, and, in many cases, the titles of the papers presented and lectures during the year

1922–23. There are also included accounts from Government institutions, such as the National Physical Laboratory, the Royal Observatory, Greenwich, and so on. In some few entries, telephone numbers and telegraphic addresses are also given; this might usefully be extended to all the societies which are served by telephone. We also think that a complete list of the various Research Associations, together with separate entries in their appropriate sections, would be valuable, while other omissions we have noted are the Institution of Chemical Engineers, the Eugenics Education Society, and the Institution of Welding Engineers.

The information provided by the handbook is furnished by officials of the societies concerned, and we must add our thanks to those of the publishers for making the volume possible. No doubt it is by a slip that the new address of the Institution of Automobile Engineers from August last has not been inserted.

Our criticism must not be taken as disparaging. In no other volume, we believe, is similar information brought together, and our suggestions are made in order that the next issue may give us cause for still more gratitude to the publishers and all concerned in issuing the handbook.

Canned Foods in Relation to Health. (Milroy Lectures, 1923.) By Dr. William G. Savage. (Cambridge Public Health Series.) Pp. vii+146. (Cambridge: At the University Press, 1923.) 8*s.* 6*d.* net.

THIS book consists of the author's "Milroy Lectures," delivered in 1923, with some amplification. The canning industry is a very important one in the United States and South America, and in the overseas Dominions. Though the industry is small in Great Britain, large quantities of canned foods are imported and consumed here. Thus in 1921 some 22,500 tons of canned meat alone (and much larger quantities of salmon and fruit) were retained in Great Britain.

Apart from the magnitude of the industry, there are special reasons why this class of food-stuffs needs supervision additional to that exercised over food generally. The most important of these is that the use of unsound constituents is less easily detectable than in the case of ordinary foods. Dr. Savage has examined various methods of manufacture, and pays a high tribute to the work done by the National Canners' Association (U.S.A.) in the improvement of the products of its members. But he finds that the control exercised over canned foods at the port of entry leaves much to be desired, and that better and more uniform methods are required for the disposal of the contents of rejected tins. Dr. Savage also urges that the date of preparation, together with a code mark for identification, should be stamped on all tins. The important subject of the causation of disease by canned foods is dealt with at length by Dr. Savage, and he comes to the comforting conclusion that canned foods as a whole are safer than fresh foods.

The book contains a very complete summary of this important subject, and concludes with appendices on the principles involved in the process of canning, and on the laboratory methods for the examination of canned foods, and with a selected bibliography of the subject.

Invertebrate Zoology. By Prof. Harley Jones van Cleave. (McGraw-Hill Agricultural and Biological Publications.) Pp. xvi+259. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 15*s.* net.

IN this volume the author "has endeavoured to collate materials which will serve as a class-room text and reference work," assuming that the student has already had an introductory course in zoology. The attempt to compress an account of the invertebrates into 240 pages is, in our opinion, scarcely successful, for it has compelled the author to deal so summarily with many of the subjects and of the classes that the accounts are too short and inadequate to be of real value; *e.g.*, endomixis is dealt with in about eight lines, and the student can form little idea of the process from a perusal of this brief statement. It would have been better, we think, to omit reference to a number of the more difficult groups, *e.g.*, Phoronida (the account of which occupies about eight lines), and deal more fully with other groups. Some of the references to protozoa require revision; *e.g.*, that *Piroplasma hominis* is the causal agent of Rocky Mountain fever, and the use of "hæmogregarines" as synonymous with Babesia is incorrect. If a cyst of *E. histolytica* is to be illustrated at all, a figure better than Fig. 24 should have been provided. We can only conclude that in a course in which such a compressed account of invertebrates is used, it is intended that much of the information on any given group will be acquired in the laboratory, the text-book serving as a brief summary for reference.

The Diseases of the Breast. By Willmott H. Evans. Pp. xii+495+102 plates. (London: The University of London Press, Ltd., 1923.) 27*s.* 6*d.* net.

THE subject of diseases of the breast is one which presents many problems to the clinician, the pathologist, and the surgeon. Mr. Willmott Evans endeavours to sum up the present views on the subject and draws on his own experience to express opinions on controversial points. His book is certainly very complete, covering anatomy, physiology, clinical examination, pathology, and treatment down to the last detail. With regard to the disputed subject of dissemination of carcinoma, Mr. Evans has no hesitation in accepting the theory of permeation described by Sampson Handley, with the reservation that embolism may account for a certain number of metastases. The book is well produced and well illustrated; it forms an excellent addition to the literature on diseases of the breast.

Statique et résistance des matériaux. Par Prof. Paul Montel. Pp. vi+274. (Paris: Gauthier-Villars et Cie, 1924.) 30 francs.

THIS book is practically a reproduction of the lectures delivered at the École des Beaux Arts by Prof. Montel on statics and the resistance of materials. The range does not differ essentially from that covered by English text-books, but to those who have a penchant for geometric in preference to analytical proofs the book is to be recommended. Wherever possible geometrical demonstrations are adopted and numerical calculations effected graphically. A number of useful practical examples are to be found at the end of each chapter.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Anomalous Emission of α-Particles from Polonium.

IN a recent issue of the *Zeitschrift für Physik*, Walther Kutzner has given the results of some careful measurements made with the view of testing the validity of Bateman's probability formula in its application to the emission of α-particles by polonium (*Vide Zeit. f. Phys.*, vol. 21, pp. 281–298, 1924). He arrives at the following conclusions :

(1) The emission of α-particles by polonium does *not always* obey Bateman's probability formula for a process of a purely fortuitous nature.

(2) Systematic deviations have been found to indicate a *subnormal* dispersion, *i.e.* the time intervals in which definite numbers of particles are observed occur more frequently, when the numbers lie near the mean value, than would be expected by the laws of probability. On the other hand, the time intervals corresponding to a large or to a small number of particles occur less frequently than theory predicts. (In other words, the familiar "cocked-hat" probability curve is higher at the crown and lower at the brim than would be expected from the theory.)

(3) It is found that the deviations are more appreciable, the greater the activity per mm.^{2} of the radioactive source.

(4) By allowing the source to decay, an improvement is found in the agreement between theory and experiment.

(5) The cause of this behaviour with polonium is discussed, and it is shown that, although the phenomena of scattering, surface oxidation, and diffusion of the polonium into the activated discs can influence the magnitude of the "subnormal dispersion," they are in themselves insufficient to explain the phenomenon mentioned in (4).

(6) For the explanation of this result it is suggested either that the individual radioactive polonium atoms mutually influence each other, or that the individual α-particles influence other atoms (atomic disruption).

From simple considerations one would not expect that an α-particle could approach the nucleus of a heavy atom sufficiently closely to bring about artificial disintegration, and hence it becomes imperative to examine whether Kutzner's results can be explained in a less drastic manner than that suggested under (6) above. The object of the present note is to show that effects identical with those observed by Kutzner are to be expected on the basis of the phenomenon of aggregate recoil, as usually obtained from sources of α-rays deposited on metallic discs. The importance of this phenomenon in the case of polonium was fully discussed in a paper by the present writer in 1919 (*Mitt. Ra. Inst.* Nr. 118, *Wien. Ber.*, vol. 128, pp. 795–830 ; also NATURE, vol. 102, p. 464, 1919), and has been confirmed by additional unpublished results, of which use will be made in what follows.

Electrolytic polonium does not consist solely of individual atoms on the metal disc, but an appreciable part of the deposit may exist in the form of aggregates of polonium atoms. Such aggregates are also formed in the case of the active deposit obtained by exposing a metal plate in emanation. When an α-particle is emitted in the direction of the plate from such an aggregate, the latter recoils from the plate, and in a vacuum leaves it entirely. Under such conditions one instance was noted in which the apparent decay of polonium was such as would correspond to a half period of 59·6 days, as compared with the true half period of 136·5 days. But even at ordinary pressures the rate of decay sometimes appeared to be so low as 127·1 days, so that even under normal conditions some of the recoiled aggregates may disappear from the plate. The number of aggregates per unit area and their complexity increase with the surface density of the electrolytic deposit, and, particularly under reduced pressures, it is the more complex groups that leave the plate first, in consequence of their containing more polonium atoms. In the course of time it follows that the polonium remaining on the disc is less and less complex, and indeed, after a sufficiently long time, one would expect the polonium remaining to consist almost entirely of individual atoms. As a matter of fact, aggregate recoil phenomena do become less marked with the lapse of time, owing to the degeneration of the aggregates, and many curious effects observed with radioactive deposits admit of simple interpretation on these lines (*e.g.* observations by Ratner, *Phil. Mag.* (6), vol. 36, p. 397, 1918).

Owing to the intense ionisation near the surface of a disc coated with polonium, it is easily seen that the aggregates, after recoil, may readily acquire a charge, and in circumstances negatively charged aggregates may preponderate.

Consideration of the above results supplies us with a ready interpretation of Kutzner's observations, for he used an electric counter of the Geiger type, in which a platinum point is enclosed in an outer metal cylinder or hemisphere, charged to a positive potential of more than 1000 volts, there being a small central opening in the front of the counter, covered with thin aluminium foil, through which the α-particles are admitted. In general, the distance of the radioactive source from the counter diaphragm, with respect to which it was centrally arranged, was from 5 to 7 mm., so that the intervening space would be subject to a strong electric field. From what has been said above, it is clear that many of the recoiled aggregates would be attracted to the aluminium foil closing the counter, so that the counts corresponding to the maximum of the probability curve would lie too high, whereas the limiting ordinates observed would be deficient. This is precisely what Kutzner noted (see (2) above). Moreover, since the formation of aggregates is enhanced for higher surface densities of the radioactive deposit, the deviations will be more marked in such cases (cf. (3) above). On the other hand, by allowing the polonium to decay, a progressive degeneration of the aggregates takes place, and the deposit acts more and more nearly like one composed of individual atoms, so that the agreement between experiment and theory improves steadily (cf. (4) above).

Using preparations of polonium of high surface density, Kutzner found, for a given source, that the deviations from theory were more considerable, the larger the aluminium-covered diaphragm through which the α-particles entered the counter. The number of transferred aggregates that are effective will obviously depend on the size of the diaphragm, being greater for larger diaphragms, so that such a result is to be expected, whereas it would be much smaller, or almost absent, when the same experiments were performed with a preparation of low surface density, and this Kutzner found to be the case.

By performing counts in which the source was first centrally opposite the entrance to the counter, and secondly, laterally displaced through 5 mm. with respect to the axis of the counter, Kutzner detected

a better agreement with theory in the latter case. This he ascribes to an influence of the direction of the α-particle beam within the counter, but it seems more likely that it was due to the fact that, in the second case, a smaller proportion of the transferred aggregates fell on the counter window. In another experiment, Kutzner found that with an unscreened source the deviations from theory were less than when the source was screened by a thin aluminium foil. This result may be, as he suggests, connected with the effects of scattering, but if the experiment were performed in the reverse order, one would expect that the screened source would give better agreement with theory than the unscreened.

Finally, Kutzner finds that counts with a willemite screen always yield results about 5 per cent. less than with an electric counter (*loc. cit.*, also *Zeit. f. Phys.*, vol. 23, p. 126, 1924). In view of the above, it is doubtful whether the whole of this difference is due to the inefficiency of willemite screens as compared with electrical counters, though it is generally recognised that deficient counts result from the scintillation method. It seems very probable that thin sections of willemite, as used by Kutzner, are more efficient than scintillation screens made from powdered willemite or zinc sulphide crystals. Were Bateman's formula to be tested by means of such screens, one would expect better agreement between experiment and theory than Kutzner found by means of the electrical counter, owing to the absence of an impressed electric field in the former case.

The deviations from theory in experiments by Rutherford and Geiger and by Hess and Lawson, to which Kutzner refers in his paper, are less systematic than his own. The former (with polonium) probably admit of the above explanation, whereas the latter were done with γ-rays and only for purposes of orientation.

ROBERT W. LAWSON.

Sheffield.

The Rotatory Dispersion of Tartaric Acid.

LONGCHAMBON (*C.R. Acad. Sc.*, vol. 178, p. 951, 1924) has recently found that the rotatory dispersion along the optic axes of crystalline tartaric acid is approximately the same as that of the lævo-rotatory component which contributes to the anomalous rotatory dispersion shown by solutions of the acid. The rotatory dispersion here referred to is measured by the ratio between the rotations for the blue (436 μμ) and yellow (578 μμ) lines of mercury. For the crystals it is 2·14, while for the lævo-component in solution it is estimated to lie between 2 and 2·22. From previous researches Longchambon had concluded that the rotatory dispersion of a given substance is a property which is conserved when the substance passes from the solid to the liquid state by fusion or solution. Applying now this generalisation to the case of tartaric acid, he states: "Le constituant gauche ne serait donc ni un anhydride ni un éther interne; ce serait l'acide tartrique ordinaire, *tel qu'il se trouve dans le cristal*; je l'appelerai 'acide tartrique α.' J'appelerai le corps droit 'acide tartrique β'; c'est la formation de cet acide β de l'acide α, par dilution ou élévation de température, qui produit les anomalies de dispersion rotatoire."

It seems appropriate now to compare these conclusions with those arrived at from the X-ray examination of the crystal structure of tartaric acid (Proc. Roy. Soc. A, vol. 102, p. 506, 1923). Out of this work it was suggested that the dextro-rotatory property of ordinary tartaric acid is associated with the carbon nucleus of the molecule, an arrangement of four carbon atoms which appears to exist in the crystal as an irregular tetrahedron, while the lævo-rotatory power is associated with the rest of the molecule manifesting itself principally through a twisted arrangement of the four hydroxyl groups, similar, but longer than and in an opposite sense, to the twisted arrangement of carbon atoms. "There is only one part of the molecule to which we can ascribe any degree of stability, and that is the nucleus of four carbon atoms arranged in an irregular spiral. Such effects as ionisation and hydration would tend to destroy the lævo-rotatory action of the four hydroxyl groups, *and it is probable that it requires the application of the forces which bind the molecules into the crystalline structure to complete the lævo-rotatory system.* Any change, such as fusion, solution, and certain chemical reactions, which leads to departure from the orientations which hold in the crystalline structure will tend to eliminate the hydroxyl spirals" (p. 527).

It thus appears that the work of Longchambon supports the conclusion arrived at from the X-ray analysis, that the lævo-rotatory component in solution is substantially the same system as that which produces the strong lævo-rotation in the crystalline form; that the tendency to crystallise and the act of crystallisation, though not unique as changes involving forces which enhance the lævo-rotatory power, are yet well-marked examples of such changes and lead finally, in the crystalline form, to the perfection and stabilisation of a lævo-rotatory system which completely overpowers the effect of the dextro-rotatory part of the molecule. From such a hypothesis it follows that, even in infinitely dilute solutions, since the molecule can never be stripped bare to the carbon nucleus above, the rotatory dispersion will still be anomalous. That this is experimentally true has been pointed out by Lowry and Austin (*C.R. Acad. Sc.*, vol. 178, p. 1902, 1924) in reply to the note of Longchambon. It also follows that the dispersion in the crystal, though the lævo-rotation overwhelmingly predominates, is probably not truly normal either. It is true that Longchambon says "la dispersion rotatoire est d'allure normale, mais très forte, . . ." but I presume this remark refers only to the region of the spectrum examined.

W. T. ASTBURY.

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Albemarle St., W.1, July 7.

Early Canadian Experiments on the Acoustic Method of Depth Sounding for Navigation Purposes.

REFERRING to the article "The Acoustic Method of Depth Sounding for Navigation Purposes" published in NATURE of March 29, 1924, p. 463, it may be of interest to record some experiments carried out by the writer in 1915 on obtaining depths at sea by the echo method.

Having had much experience in carrying on fog alarm researches at Father Point, Que., for several years from 1913, the writer felt in the early days of the War that this site would be an admirable one for carrying out researches on submarine acoustics, with the view of solving some of the problems relating to the submarine situation in Europe. In addition to the facilities for experimental work, such as isolation, wharfage facilities, calm weather, easy access to a main railway line, etc., an important consideration was the fact that supplies of scientific material from America and co-operation with American men of science could be obtained on Canadian territory before the United States had yet entered the War.

In the early autumn of 1915 a plan and report to this effect was sent to the Minister of Marine and

Fisheries; and, while the question was being considered by the Canadian Government, a start at actual research was made with the co-operation of the Submarine Signal Company of Boston, Mass., U.S.A. It was decided to repeat the experiments of Prof. R. A. Fessenden (Trans. Am. Inst. of Elect. Eng., vol. 33, Oct. 1914, pp. 1569-1581) "On Obtaining the Depth of the Sea by the Echo Method." A Fessenden oscillator with the associated motor generator set was installed on the Canadian hydrographic survey ship *Cartier*, and during the month of October 1915, numerous experiments were tried on "depth sounding" (Fig. 1). A short experience showed that for moderate depths, 30 to 40 fathoms, the same oscillator could not be used for receiving the echo, on account of the persistence of transients in the electromagnetic circuits. A separate hydrophone, shielded from the oscillator signal by being placed on the opposite side of the ship, was therefore employed, and experiments, though for the most part unsuccessful on account of the weak echoes received from a sea bottom of soft ooze and clay, gave indications at favourable localities as to the ultimate possibilities of this method.

At this early date and under war conditions, it was practically impossible to obtain thermionic amplifiers

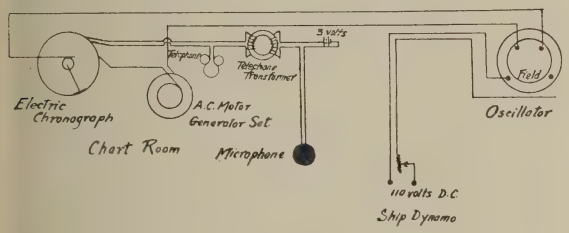


FIG. 1.

by means of which echo signals could be received. Then, too, for the faint echoes involved, the type of hydrophone available was not sufficiently sensitive, while for experimental work the type of oscillator available, weighing 1300 lb., was inconvenient for overboard use, especially with the ship in motion.

In a report submitted to the Electrical and Submarine Committee of the Admiralty Inventions Board, it was finally concluded that special transmitters of less weight, designed for inboard use, would have to be developed in conjunction with a more sensitive type of hydrophone. In order to obviate the use of thermionic amplifiers as much as possible, it was decided to make use of a hydrophone, suitably damped, capable of tuning in to the definite wave-length emitted.

A tuneable diaphragm, forming an essential feature of a hydrophone, was briefly described in the Proc. Roy. Soc., London (99-A, 1912, pp. 163-171). At the request of the Inventions Board the complete mathematical theory of electrically operated sound generator was undertaken, with the view of facilitating design.

It will be readily seen that a diaphragm both for emitting and receiving corresponds to the aerial in radio-telegraphy. In the latter field, the enormous advantage of the aerial tuning condenser for the selection of narrow wave-length bands is the characteristic feature of modern radio transmission and reception, an enormous increase in the range of communication having thus been effected. In just the same way, the writer anticipates a radical improvement in the art of submarine signalling by the introduction of tuneable diaphragms enabling specified wave-lengths to be picked up to the exclusion of others.

During the past few years the writer has been working at improvements in the construction of transmitters and receivers based on the principle of selective tuning, which it is hoped may find a useful field of application in an improved system of depth sounding for navigation purposes.

LOUIS V. KING.

McGill University, June 15.

Study of Explosions.

SIR OLIVER LODGE, in NATURE of July 5, p. 10, suggests that the methods of producing the "Big Bangs," which have previously been used, may not be the most effective for the purpose.

While on service in France with the Artillery, it appeared evident to me that the noises with the greatest "carrying power" were made by the gun discharges, and not by detonations of high explosive shells.

The battery with which I was at the time was a 6-in. howitzer battery, and I noticed that the detonations of our own shells, although visually observed from an O.P. at 2000 or 3000 yards range, were often inaudible; whereas an enemy gun or howitzer at the same order of distance was always distinctly heard.

The noise of the great bombardment near Ypres in 1917, which was clearly heard from the South Downs in England, always seemed to me to be that due to the guns themselves, and quite unlike the characteristic "c-r-r-rumps" of H.E. shell detonations.

It seems possible that the detonation of a high explosive must produce an air wave of a very steep wave front, which may be damped out by the internal friction of the air particles more rapidly than the slower rise and fall of pressure produced by the combustion of the propellent type of explosive.

It is to be hoped that Sir Oliver Lodge's suggestion that in a future trial a charge of gunpowder or cordite should be exploded, in some form of container if necessary, at a considerable height from the ground, will be adopted.

P. J. RYLE.

Hadley House, Pangbourne,
Berkshire.

IN view of the recent attempts to utilize surplus munitions of war in the investigation of the propagation of sound in the atmosphere, it may be worth while to direct attention once more to the opportunity that explosions afford for investigating the propagation of seismic waves in the upper layers of the earth's crust. In the Oppau explosion 4000 tons of explosive produced a wave that was recorded by a seismograph at a distance of 365 km. This was a surface explosion. The momenta communicated to the air and the earth by the shock must have been equal, and therefore the amounts of energy that went into the air and the earth must have been in the ratio of the velocities; thus much less than a thousandth of the energy can have gone into the seismic wave. If, however, the explosive is buried deep in the ground, nearly all the energy will go into the earth. Thus a wave of intensity greater than that produced by the Oppau explosion could be produced by firing 4 tons of explosive underground. Further, timing could be made specially easy by having the explosion in wireless communication with the observatories, thus eliminating the uncertainty of the time at the focus.

HAROLD JEFFREYS.

St. John's College, Cambridge.

Different Types of Ions in Hydrogen.

In a previous letter (NATURE, June 16, 1923, p. 810), and more recently in the Proceedings of the Royal Society (105, p. 116, 1924), I described some experiments on the products of ionisation in hydrogen, nitrogen, and oxygen. It may be recalled that the method depended on the combination of an ordinary ionising potential arrangement with a simple positive ray analysis apparatus.

For hydrogen the principal conclusion drawn was that ionisation at 16·5 volts was not accompanied by dissociation. This conclusion rested on results at very low pressures where no atomic ions were detected below twenty volts and comparatively few even up to the highest voltages used. It was found, however, that at higher pressures the relative intensity of the atomic ions, H^+, became much greater, apparently due to a secondary dissociation of the molecular ions, H_2^+. No appreciable number of triatomic ions, H_3^+, had been observed at low pressures, and no search was made for them in the few experiments made at high pressures.

I have now set up an entirely new apparatus very nearly identical with that used in Cambridge and wish to report further results. The conclusion that the primary product of ionisation in the neighbourhood of 17 volts is H_2^+ has been confirmed. However, as the pressure is increased, it is found that H^+ does not necessarily become dominant. The effect due to H_2^+ becomes smaller and both H^+ and H_3^+ increase in intensity, but their relative size depends on the arrangement of the electrical fields (to be specific, on the strength of the field designated V_2 in previous communications). Thus, by varying conditions of pressure and electric field it is possible to produce almost any desired proportions of the three types of positive hydrogen ion.

The new evidence on a possible critical potential at about 20·8 volts corresponding to ionisation accompanied by dissociation is not conclusive, but makes its reality very doubtful.

The most interesting new result I have to report is, perhaps, the observation of peaks corresponding to apparent values of $m/e = 1/2$ and $1/3$. These are not attributed to anything so unexpected as doubly and trebly charged hydrogen nuclei, but merely to ions which have fallen through the entire electric field as H_2^+ or H_3^+, but which break up in the field-free space between the two slits before passing into the magnetic field. It is nevertheless remarkable that the atomic ions so formed should retain the direction and velocity of the original ions sufficiently to pass on through the magnetic field and produce a "peak." Obviously these results suggest a reinterpretation of the effects in nitrogen and oxygen previously attributed to doubly charged atoms. They also offer interesting possibilities for studying the mechanism of ionisation.

These points and others will be taken up in a full report of the work which I hope to write in a few months. H. D. SMYTH.

Palmer Physical Laboratory,
Princeton University,
Princeton, New Jersey, June 4.

Transplantation of Heads of Insects.

It may be of some interest to biologists if I supplement Dr. W. T. Calman's letter under the title of "Chimæras Dire" (NATURE, July 5, p. 11) by a brief record of some experiments of my own. Not having any water-beetles available at the time, I tried to repeat Dr. Finkler's experiments on meal-worms. I cut off the heads of two pairs of specimens, and interchanged those of each pair. In a third case I had a single specimen which had recently moulted, and after removing its head put in its place that of another individual. The heads became attached to the alien bodies. I kept the specimens in Petri jars with a little meal. They made no spontaneous movements, but showed signs of life for a varying number of days, the maximum number being five. The signs of life in question were response to stimulation of the body with a blunt point. The head seemed to be dead long before the body. The only remarkable thing in the result of these experiments was the tenacity of life of the insect body after decapitation, and it may be doubted, especially after the results of Drs. Blunck and Speyer, whether anything more occurred in Dr. Finkler's experiments. J. T. CUNNINGHAM.

21 Gower Street, W.C.1.

Velella at Port Erin.

We have just found enormous numbers of the remarkable Siphonophore *Velella spirans* cast up by the tide in a neighbouring bay (Perwick). My daughter and a friend first noticed some specimens floating in a shore pool, and then we found abundance amongst the wet sea-weed at high tide mark, and picked up several hundreds in a few minutes. They were all dead, but many still showed the polypes and tentacles and the beautiful violet coloration.

This is not actually a new record for the Irish Sea, though a very rare event. A similar case was recorded, I think, in the first volume of the L.M.B.C. "Fauna of Liverpool Bay" many years ago, and probably indicates an exceptionally marked inflow of Atlantic water. Those who are now studying the variations in the movements of the currents and the plankton in British Seas may be interested to hear of this unusual occurrence. W. A. HERDMAN.

Port Erin, July 13.

A Rare British Oligochaet.

In Mr. Beddard's Monograph of the Oligochæta, p. 216, reference is made to *Rhynchelmis limosella* Hoffm., in these words: "There is every probability that it is a native of this country." I reported the finding of a specimen some years ago at Ringwood, but there was an element of doubt. Now, however, I am in receipt of an excellent specimen sent me by Mr. W. J. Lucas, which puts the matter beyond all question. Mr. Beddard thinks there is a specimen in the Oxford Museum, but I have had no confirmation of this. HILDERIC FRIEND.

"Cathay," Solihull.

Physical Properties of Clay.

The late Dr. R. Mullineux Walmsley was interesting himself in my work on the above subject, and for this purpose I lent to him my own special set of my five papers on the subject which were read before the Society of Engineers in the five years 1919–1923 inclusive. Unfortunately, this set has not been found among Dr. Walmsley's papers either at the University of London, the Northampton Polytechnic, or at his private house, and, knowing how careful he was, this points to his having probably lent the papers to somebody in connexion with the matter with which he was dealing. As the sets of these five papers are now so scarce, and especially as the set in question was my own private set, if this letter meet the eye of the person to whom the set was lent, I shall be greatly obliged if he will be so good as to return it to me. A. S. E. ACKERMANN.

17 Victoria Street, S.W.1.

Colours, Stains, and Dyes.[1]

By Prof. J. F. THORPE, F.R.S.

THE great majority of chemical substances occurring either as natural products or as the outcome of synthetic preparations in the laboratory are colourless. In other words, white light reflected from their surfaces or transmitted through these solutions is unaffected so far as its balanced colours are concerned and emerges unaltered. The absorption of light in these cases is general; that is, it takes place equally throughout the visible range of the spectrum and the object, therefore appears colourless.

On the other hand, there are a number of substances which possess the property of absorbing certain portions of the visible spectrum while reflecting or transmitting the remainder. These substances, therefore, appear to the eye to be coloured in accordance with the portion of the spectrum transmitted or reflected. A red substance is one which absorbs the blue region of the spectrum; a blue substance one which absorbs the red region, and so forth. This is known as selective absorption. Again, there are a number of substances, chiefly members of the carbon family, which have the power of absorbing rays outside the visible region of the spectrum—for example, in the infra-red or the ultra-violet—and these substances, since they possess selective absorption, must be regarded as coloured in a chemical sense, although the "colour" they transmit or absorb is not visible to the eye.

The hydrocarbon benzene is an example of the type of chemically coloured substance, and, as we shall find later, this property possessed by benzene causes it to be the parent substance of those very numerous and industrially important materials—the coal-tar dyes.

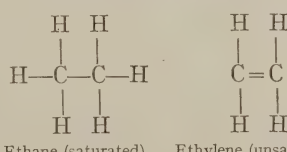
It is not in its lack of power to detect the ultra-violet range alone that the eye fails as an organ of vision, because even in the visible region its power to detect the end colours is seriously restricted. It is most sensitive towards green and red.

The power of a chemical substance to produce selective absorption is without doubt due to its chemical structure; that is to say, white light is "filtered" through the molecular structure of the substance, leaving a "portion" behind in its passage. The colour is therefore dependent on the chemical composition of the particular compound. On the other hand, it is possible to produce visible colour by entirely physical or mechanical means, as, for example, by ruling a number of fine lines on glass, and in these cases colour is independent of chemical structure, being entirely physical in character.

Nature, in producing the variety of coloured substances around us, has adopted both the physical and chemical methods to achieve her ends. The colour of flowers and leaves has been brought about by the use of coloured chemical substances, and these I shall deal with later. But many of the colour effects produced in the wings and feathers of birds and in butterflies are not due to the presence of any coloured substance in them, but to the arrangement of fine filaments or hairs, which serve the purpose of disintegrating white light and reflecting the desired shade of colour. The best test for this kind of colour effect is to examine the coloured object by transmitted light. If no colour is transmitted the reflected colour is probably due to physical causes.

A considerable number of the chemical substances which owe their colour to structure are inorganic in origin, and the colours depend mainly on the presence of some colour-producing metal; for example, chromium, cobalt, copper, and so forth. They are mostly used as pigments for the production of coloured surfaces by painting, or for the production of coloured decorations on china. Of these I do not propose to make any mention, not because they are unimportant as coloured substances, but because they do not trace any relationship to the stains and dyes which belong to organic chemistry, and are bound up with the recurrence of one particular element, namely, carbon.

There are some 300,000 definite compounds of carbon known, and the activities of research chemists add, perhaps, 4000 to these yearly. The majority of these compounds are colourless in the sense that they give only general absorption throughout the visible region of the spectrum. Some are, however, coloured—that is, they give selective absorption within the visible region—and it is evident that in these cases the colour cannot be ascribed to the presence of some particular metal, as with the metallic pigments, but must be due to some special condition of the element carbon. As a matter of fact, it is due to what is known as the "unsaturated state." The greater number of known compounds of carbon are "saturated" in the sense that all affinity which the carbon atom possesses for the atoms of other elements is fully satisfied. This is the case when carbon combines with hydrogen to form methane CH_4, or when it combines with oxygen to form carbon dioxide CO_2. No carbon compound of this type possesses colour, and every "saturated" compound shows general absorption of light. It is possible, however, to cause carbon to combine with carbon by more than one valency, and in such a case a condition of "unsaturation" arises:



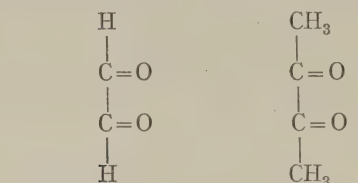
Ethane (saturated). Ethylene (unsaturated).

The affinity of each carbon atom is no longer satisfied by its proper quantity of hydrogen (or oxygen), and since there is naturally always a tendency for the substance to acquire the hydrogen atoms necessary for saturation, the "unsaturated" condition is definitely less stable than the saturated state.

The presence of one unsaturated linkage does not, however, confer colour on an organic compound—at least two being necessary for the purpose. It is also necessary that the two double linkages should be separated by one single linkage. This is known as the conjugated system of double linkages, and its presence in an organic compound apparently confers on it the property of producing selected absorption in the visible

[1] Discourse delivered at the Royal Institution on Friday, April 11.

region of the spectrum. The simplest possible coloured organic substances are therefore glyoxal and diacetyl:



Glyoxal. Diacetyl.

These substances, however, although they are of great interest as showing the origin of colour in organic substances, are relatively unimportant owing to their slight colour and their rarity. It is to the derivatives of the hydrocarbon benzene, upon which is based the chemistry of the coal-tar colour, that special interest attaches.

As already mentioned, benzene shows selective absorption in the ultra-violet region of the spectrum, and is therefore visibly colourless, although, chemically speaking, it possesses marked colour. The great number of the derivatives of benzene are, therefore, visibly colourless, but the chief point which has to be remembered is that, although visibly without colour, these derivatives possess potentially visible colour, and it is always possible to produce visibly coloured substances from them by modifying the molecular conditions which lead to the selective absorption causing visible colour.

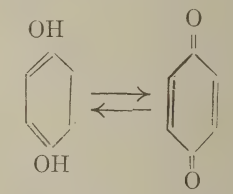
The organic chemist's conception of the structure of benzene is still that which was propounded by Kekulé some seventy years ago, and it is fair to say that no theory, either physical or chemical, has been brought forward since then which can be regarded as quite adequate. Kekulé regarded benzene as a substance containing a conjugated system of double linkages, upon which the colour of organic substances depends; but in order to account for the peculiar properties of benzene, its remarkable stability, and the formation of its derivatives, it is necessary to postulate a symmetrical formula which is expressed either by the Armstrong formula or by the simple hexagon—a necessity, which was met by Kekulé by the supposition that there was rapid dynamic interchange between the two unsaturated individuals of his formula. Below are given the forms of linkages which have been given to the benzene molecule, the carbon atoms, assumed to occur at the points of the hexagon, being omitted:

Kekulé (I). Kekulé (II). Armstrong. Conventional form.

This dynamic interchange, leading to symmetry, is expressed both by the Armstrong formula and by the conventional formula, but it is evident that each of them is merely a compromise, and represents an intermediate condition between two rapidly interchanging forms. They do not mean more than this, because any condition which postulates the existence of trivalent carbon has to contend with a number of cases in which the occurrence of this condition leads to instability quite out of keeping with the remarkable stability of benzene and its analogues and derivatives. This is the case with triphenylmethyl and similar compounds.

The dynamic conception of the structure of benzene supplies a reason for the recurrence of the strong ultra-violet absorption which is characteristic of this substance. Moreover, it suggests that if it were possible to modify the conditions leading to this absorption it might be possible to throw the absorption within the visible range of the spectrum, and thus produce visible colour.

The simplest visibly coloured member of the series is quinone, which is produced easily from hydroquinone by oxidation and is reconverted into hydroquinone on reduction:



Hydroquinone. Quinone.

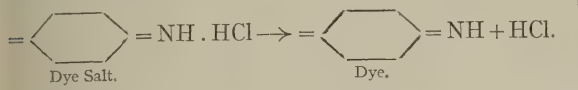
Here, then, at any rate, we have one means by which we can produce visible colour from a benzene derivative. There are certainly other means, but these are not as yet so clearly defined, and there is no question that when H. E. Armstrong propounded his quinone theory of colour he enunciated the fundamental principle on which the chemistry of the coal-tar colours is based. For there can be no doubt that the colours of these compounds are due to the presence in them of a quinone residue, which, acting like the simplest quinone ring shown above, throws the ultra-violet absorption of the visibly colourless benzene derivative into the visible region of the spectrum.

This is easily shown by the conversion of the visibly colourless phenolphthalein into its coloured alkali salt. However, it is a simple matter by altering the groups present to throw the absorption into any portion of the visible spectrum required, and thus to obtain any desired colour. The chemist is able, therefore, while retaining the same skeleton, to produce any colour at will by merely altering the nature of attached groups.

The name coal-tar colour is derived, of course, from the fact that the parent hydrocarbons from which the colours are derived—the benzene hydrocarbons and their analogues—are obtained by the distillation of coal-tar. The first of the series, mauveine, was discovered by the late Sir William Perkin in 1856, in an attempt to prepare the alkaloid quinine synthetically. But Perkin did more than discover a new series of colouring matters. He also introduced a new method of dyeing. Up to that time, dyeing had been a composite process involving the actual formation of the coloured substance on the fibre itself. The two chief processes in use were (*a*) that of vat-dyeing and (*b*) that of mordant dyeing. The first, represented by indigo dyeing, involved the reduction of the coloured substance (indigo) to indigo-white, a material soluble in alkali; the steeping of the fibre in the solution and the reproduction of the insoluble dye by means of the

oxygen of the air. The second required the previous impregnation of the fibre with a metallic hydroxide and the subsequent formation of a coloured lake on the fibre by steeping the prepared material in a dyestuff (alizarine) capable of yielding such a lake.

In each case, therefore, two distinct processes were involved. In the process introduced by Perkin only one operation was necessary. The dye contains, as already mentioned, a quinone or quinonimine residue, which causes the dyestuff in the form of its salt to be soluble in water:



It happens that the coloured base is soluble in the wool fibre, and when the fibre is added to the dye-bath the coloured base is extracted, leaving the mineral acid free in solution. The operation is of the same order as that which determines the extraction by, say, ether of an organic substance soluble in water. The coloured base is not, however, soluble in cotton, and hence this material is not coloured in the dye-bath.

These are known as the basic dyes; and a similar effect is produced by the acid dyes, although, since these are the sodium salts of sulphonic acids, the dye-bath has to be rendered acid previously in order to liberate the free sulphonic acids, which then dissolve in the substance of the wool. Cotton would not, of course, be coloured by this process, although, as it was found that the new basic colours possessed the power of giving an insoluble coloured compound with tannic acid and an antimony salt, it was possible to affix them to the cotton fibre by a two-process method, involving the previous treatment of the material with tannic acid and tartar emetic.

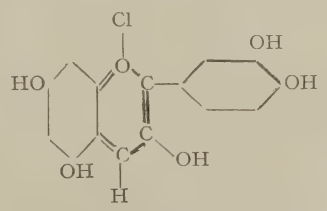
It was not until twenty years later that it was found (Böttinger, 1886) that a certain type of azo-dye derived from benzene possessed the property of being soluble in the cotton fibre, a discovery which led to the preparation of the large number of substantive cotton dyes known at the present day. In this case it is the sodium salt of the sulphonic acid which is extracted. This discovery was entirely accidental, but, as so often happens in organic chemistry, it was found that the property was possessed by a large number of substances of the same type, or having the same skeleton formation, and, since it is possible readily to alter the shade by varying the nature of attached groups, the series contains representatives of all shades of colour.

It must be remembered, however, that there is a marked difference between the two methods of dyeing —one, the older method, in which the dye is formed in the fibre, and the other, the newer method, in which the fibre acts merely as an extractor for the coloured base, acid, or salt. It is evident that, other things being equal, the older processes should give the faster dyeings; that is, the colour would be more firmly fixed in the fibre and less likely to be affected by the various conditions, such as exposure to light, washing, etc., to which a dyed fabric has usually to be subjected. This is, as a matter of fact, the case, and numerous processes have been devised by which the stained fabric (as I prefer to call it) can be rendered more fast by after-treatment; that is to say, by causing another colour to be produced in the fibre from the colouring matter already there. One of the best illustrations of this is the method by which an azo dye can be produced on the fibre from a stained fabric which has been stained by a substance having an NH_2 group:

$$-NH_2 . HCl \rightarrow -N=NCl \rightarrow -N=N . R . OH.$$

There are many other methods, such as after-treatment with metallic salts, or with formaldehyde, which can be employed. Indeed, such processes would be still more necessary were it not for the remarkable tenacity with which the stained fabric, in many cases, retains its stain. The affinity varies in different cases, both as regards the power and speed of absorption, and is probably connected with the size of the molecular (colloidal) aggregates which are present in the dye-solutions. It is not connected with the actual molecular weights.

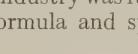
Nevertheless, although there are some stains which possess so marked an affinity for the fibre as to render them comparable with true dyestuffs (those produced on the fibre) in fastness, and some which lend themselves to after-treatment, and fall therefore within the category of true dyestuffs, there are a large number which possess all the inherent disabilities of the class; that is, they are unsaturated organic compounds tending to pass into the saturated (colourless) state under favourable conditions. Such conditions are always present in the oxygen of the air, which in the presence of light constitutes a formidable opponent to all coloured organic compounds. As already mentioned, Nature got over this difficulty in the case of bird's feathers and butterfly's wings and also in the wing cases of coloured beetles by ignoring the organic colour altogether. She utilised them, however, in the case of the flowers, but chose substances highly oxygenated in structure, which would be least likely to be affected by air and light. For example, the colour of the red rose is delphinidine,

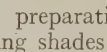


and this is also the basis of the colour of the blue cornflower, the only difference being in the character of the group attached to the oxonium oxygen.

However, as the science of organic chemistry advanced, it became possible to contemplate the synthetic preparation of some of the natural colouring matters, of which indigo, alizarine, and logwood were types. These are not natural colouring matters in the sense that they are used by Nature as such, but have been evolved by man for his own purpose by a process of trial and error. They represent the survivors of a vast number of natural substances with which man must have experimented throughout the ages in order to produce colour for his own purposes. Together with certain mordant colours derived from lichens, which are still used for dyeing in certain parts of the country, they constituted the sole means of producing

dyed fabrics at the time when the coal-tar colours were discovered. Their value as dyestuffs was without question, the world's yearly consumption of indigo alone, at that time, representing some 4,000,000*l.*

It must also be remembered that it was not the question alone of the commercial production of the dye in competition with the natural product which was sought, because this must have appeared a totally impracticable problem in those early days. It was rather the search for the reason why alizarine was a mordant dye and why indigo was a vat-dye which was the incentive to research, because when these facts were discovered other substances having similar properties could be prepared. The attack in every case followed the usual lines. In the first instance, the structure of alizarine (the mordant dyestuff of the madder root) was revealed by analysis, when Baeyer found that it gave anthracene on distillation with zinc. Its synthesis from the anthracene of coal-tar followed in the next year, being effected almost simultaneously by Graebe and Liebemann in Germany and by Perkin in England. In this case the preparation was so simple and the raw material so easily obtained that the natural madder industry was rapidly killed. The determination of the formula and synthesis of alizarine showed the particular grouping, namely,  , on which mordant dyeing depended. Hence the preparation of a large number of analogues of varying shades of colour followed.

The determination of the structure of indigo took longer, and occupied Baeyer at Munich some eighteen years. In this case the colour was synthesised and manufactured on a commercial scale three years before its structure was determined, because, as sometimes happens, a reaction, the course of which was then unknown, led to the formation of the dye. Here, again, the determination of structure showed that the property of vat-dyeing depended on the presence of the grouping  , and in consequence, whereas blue indigo was the only known member of its class in 1890, at the present day every shade of colour is represented in this particularly fast series.

Finally, at the beginning of the present century, the accidental discovery of indanthrene by Bohr placed on the market the first member of a series of vat-dyes, which constitutes without question the fastest series of colouring matters hitherto prepared. Practically all shades of colours are represented, the principle of dyeing being essentially the same as that of indigo.

Before the War we relied mainly on Germany for the production of our dyestuffs, and, what was still more serious, we left to them the research work on which the production of new dyestuffs depended. Dyestuff chemistry is merely a branch of organic chemistry, which includes also the preparation of organic chemical substances used in a variety of industries essential in peace and war. The possession of a dyestuff industry implies, therefore, the possession of a band of trained organic chemists and, what is more important, the possession of university and university college laboratories, where organic chemists can be adequately trained in methods of research. As a member of the Dyestuffs Development Committee, it has been my good fortune within the past six months to visit all the dye-producing factories operating in Great Britain, and I have been struck with the very real success which has attended the efforts of the past five years to establish the industry. If we had merely reached the level of excellence attained in Germany before the War, the fact would have been very creditable, but we have done more than this, and in several cases, notably in the production of a new indanthrene green, we have already drawn ahead; a position, it is to be hoped, we shall not again lose.

Some Geographical Aspects of the British Empire Exhibition.

THE British Empire Exhibition at Wembley, in the north-west outskirts of London, strikes at once a note on the Empire as a unit. From the Palace of Engineering, with its sense of the fullness of the metallurgical industries of Britain, across the way to the Palace of Industry, almost crowded out with the multifarious products of Britain's factories, one gathers an impression of diversity as shown by fountain-pens and gramophones in contrast with big guns and giant railway engines, of high quality from the silks and laces to the coach-work on the motor cars, of stability from the various types of safe and strong room to the giant turbines; and, withal, there is a feeling of much energy crowded into a tiny space. Visit may succeed visit to these two great palaces, the main monument to the occupations of Britons at home, and yet their innermost recesses, their by-ways, and their out-of-the-way corners would not all be explored; it would appear that the visitor is left deliberately with few indications of the wealth of British products here housed, for each visit brings to light something previously missed and leaves the thought that there is yet something more to find.

The British Isles are thus presented as a crowded hive of industry, and this impression is intensified when one penetrates below the surface. Mannequin parades, exhibits of machine processes in cotton, paper, and so forth, are co-operative efforts; they are not labelled as the work of one firm or as, necessarily, the product of one district; they are specimens of Britons' work. The student of geography who wishes to emphasise or correct his book-lore is driven to much mental effort to analyse the contents of these great buildings, to sort out the products, say, of the Black Country and to localise the various elements of industrial Britain. Except in a few instances, mainly in the food section, the visitor is not asked to buy, and the exhibit is not primarily designed as an advertisement; in this respect the student would penetrate deeper and more easily into the mysteries of British manufactures at one of the annual trade shows, such as the British Industries Fair or the Motor Show. Of course, customers from overseas can get into touch with manufacturers, but the trading element, the business of selling the goods, is kept in the background; here is primarily an exhibit of what

can be produced by the British Isles as the chief congeries of factories in the Empire.

Over against the impression of works jostling with works to pour out useful commodities for use throughout the Empire lies the first, and the dominant, feeling which is aroused by the pavilions devoted to Australia, Canada, and New Zealand. Each of these suggests life in the open spaces where there is room and to spare for all; a largeness and perspective about the exhibits strikes immediately the right note. In the same spirit the divisions of the country are obscured; it is intentional that the visitor should have to make an effort to discover whether he is examining the products of New South Wales or Victoria, of the Canterbury Plains or Taranaki. Take the simple matter of apples; the housewife at home is concerned with the quality of the fruit, not with the location of the orchards; in each pavilion she may see and buy fine specimens, and she carries away the notion that the greengrocer may supply Canadian, Australian, or New Zealand apples; she may see adjacent pictures of Canadian orchards and only after diligent inquiry learn that one picture shows life in the Annapolis Valley and the other a scene in British Columbia, places 3000 miles apart. Similarly, butter is seen in refrigerating chambers in Canada and New Zealand, sheep are sheared in Australia, timber of all kinds, undressed, dressed, worked into furniture, is shown from all three countries. Canada invites attention to her magnificent water supply with its uses for power installations; Australia indicates by a model farm the irrigation of an arid area.

In these pavilions, as elsewhere, the complete exhibit is a concrete demonstration of the products of each country as a whole, and the best guide to the pavilion is probably a list from a Blue-book of the products of each land; there is little attempt to indicate relative importance; each country says simply, This is what we can do, this is our contribution to the Empire's needs, will the Empire make use of our efforts?

In this regard the main part of each show deals with a few primary products, meat, wool, ores, timber, but a similar note is struck regarding the factory products of the chief towns. Emphasis is not laid upon the work of Toronto in competition with Montreal or of Melbourne rather than Sydney, but upon the one main fact that Canada and Australia can make house furniture, boots and shoes, apparel, and so on, of a quality which exceeds expectation. Canada is not merely a farmer's land, a land of the backwoods and prairie; Australia is more than a home for the squatter or the bushranger. Even the prairies or the Australian back-blocks are no longer the scene of primitive human labour, that of the hands; the prairie quarter section is depicted near a railway with a convenient elevator against which a moving train stops until the grain has poured into the truck; Australian sheep are sheared and Australian cows are milked by machinery.

Leaving the spacious lands the visitor reaches, in turn, India, Burma, and Ceylon, and again receives the right impression of crowds and ceaseless activity, but with this difference, that the activity is concerned, on the whole, with products each of small import. So there comes before him the questions of cotton, tea, and rice. In the Palace of Industry a cinema has told him the story of cotton, and machinery has whirred and clanged as the fabrics were made before his eyes; here are the raw material, the native weaver, and the native product all in readiness for the contrast to be obtained from a subsequent visit to the African pavilions to find experimental cotton growing and other native looms at work.

Here, and more forcibly at Hong-Kong, the spirit of the Eastern bazaar is displayed; here is the peddling of home-made products and the country's curios. Rightly, perhaps, the primitive elements of Indian life are hidden except in relation to the ameliorative work of the missions, India being presented rather from the point of view of the business and needs of the Empire than from that of a true perspective picture of what Indian life is like in all its degrees.

Thus the visitor passes to the smaller sections of the Empire, the best guide, as always, a Blue-book list of products, cocoa, kola, palm oil, rubber, and so on, for the Gold Coast, for example, and in addition, both within and without the pavilions, a skilled attempt to produce the essential atmosphere of the colony with native craftsmen, native scenes, and the products of domestic industries. The tour so far has been a continuous descent in the scale from the English locomotive and the Canadian motor-car to the Indian shawl and the West Coast brass or silver bowl with a hammered pattern, from a Doulton vase to a piece of African pottery. Diamonds, gold, ostrich feathers in South Africa, fish, paper-making, and the Newfoundland dog in Newfoundland, oranges in Palestine, an interesting historical exhibit in Malta, whaling and sealing in the Falklands, copra in Fiji, are but a tithe of the things to see in the remaining pavilions.

Imperial communications are focussed in an interesting model in the Government pavilion, but they are constantly to the fore elsewhere, either in the separate pavilions of the Canadian railways, or as specimens of railway carriages or ship's quarters or as model steamers or models of docks and wharves in the several Imperial units. The would-be settler has every inducement to find out all he wishes to know about any land which attracts him, and Imperial comparisons are possible under the guidance of the Department of Overseas Trade.

Health questions in the Empire are dealt with in the Government pavilion in a section which deserves to become more popular.

In every corner the visitor is carried away to some distant land, from every detail he gathers a suggestion which leads cumulatively to a notion of what each name, Malaya, British Guiana, East Africa, implies, and even a scamper of merely one day's visit through the several pavilions gives reality to these far-off homes of Britons overseas, and the wise visitor probably pauses and looks back over the pavilion itself to grasp the message it conveys; the colour scheme of West Africa, the caribou and bison of Canada, the Maori whare and Samoan hut, the pillars at the entrance with the pagodas of Burma, the Indian pavilion as a whole, all contribute to the general effect, which is intensified by the slow passage over Old London Bridge with the views from either end, the old heart of the Mother City brooding over the wonders brought into being by her sons, the Empire builders.

The Toronto Meeting of the British Association.

LOCAL ARRANGEMENTS.

(From our Toronto Correspondent.)

THE local arrangements for the Toronto meeting of the British Association in August give promise of an interesting time for visitors from the east side of the Atlantic. Committees have been busily engaged with arrangements for local entertainments, sectional excursions, and the main excursion through western Canada to the Pacific coast, which is to take place after the meeting. It is now possible to give a summary of the arrangements which have been made.

The main party of visitors from England is expected to arrive in Quebec on August 2. There they will be formally and appropriately welcomed, and will spend a day at Quebec, leaving late in the evening. They will arrive in Montreal on the following day, and accommodation is being reserved at hotels where visitors will spend a welcome day of rest. On August 4 excursions have been arranged to Macdonald College and to the Port of Montreal. A botanical excursion has also been arranged. While definite plans have not yet been made, it is proposed that the party be divided in Montreal into two approximately equal groups. One of the groups will leave for Ottawa late in the evening of August 4, and will spend the morning of August 5 there, take part in certain official functions and entertainment, and leave for Toronto at midday. The other group will go directly from Montreal to Toronto by night train on the evening of August 4, arriving in Toronto on the Tuesday morning.

For the social side of the meeting in Toronto, several garden parties, receptions, ladies' luncheons, and other entertainments have been arranged. Among these are a recital of Canadian music and the performance of a Canadian play in the theatre of Hart House. An exhibition of Canadian paintings will be on view throughout the meeting at the Toronto Art Gallery, which is five minutes' walk from the University.

On Thursday, August 14, a general excursion has been planned to Niagara Falls. Other excursions to Niagara Falls and its vicinity will be undertaken by sections for their own purposes, and it is suggested that those who wish to go to Niagara primarily to see the Falls should take part in this excursion on August 14 to avoid unnecessarily enlarging the sectional excursions during the meeting.

The following sectional excursions have been planned:

On August 8 the Chemistry Section will visit the industrial plants around Niagara Falls, Welland, and St. Catharines. On this excursion the chemists will spend the night at Niagara Falls.

The Geology Section will make the following excursions:

On the afternoon of August 7, together with a limited number from the Geography Section, they will travel by motor-cars to various points in the vicinity of Toronto where palæozoic rocks may be seen. The party will be under the direction of Prof. Parks, of the University of Toronto, and is limited to fifty. On the afternoon of August 8, under the direction of Prof. Coleman, they will visit various localities in the vicinity of Toronto for the purpose of studying glacial phenomena. This party, which will travel in motor-cars, is limited to seventy-five. On August 9-10 they will visit the Niagara-Grimsby district under the direction of Profs. Coleman and Parks. This excursion is limited to sixty participants. If a sufficient number desire, arrangements will be made for another excursion to the Pre-Cambrian area in eastern Ontario. This excursion would leave Toronto on the evening of August 8, and return on the evening of August 10. It would afford an opportunity for studying the Laurentian and Grenville formations.

In the Zoology Section there will be a motor trip on the afternoon of August 8 to the Forks of the Credit River; on the afternoon of Monday, August 11, a motor-launch trip on Lake Ontario for the purpose of examining the plankton; and on the afternoon of August 12 a motor-car excursion to Schomberg Swamp on the Holland River.

In the Engineering Section on August 9 the engineers will journey by steamers and cars to various engineering works, such as the Welland Canal and the Queenston Power Plant, in the vicinity of Niagara. This excursion will occupy the whole day. On August 11 they will inspect the works of Toronto harbour, making the tour by boat.

The Psychology Section will make a motor excursion to the Ontario Hospital at Whitby on August 9.

The botany excursion will visit High Park, Swansea, and Humber Valley on the afternoon of August 7. And from the evening of August 8 to the evening of August 10 they will camp in the vicinity of Niagara Falls and make various excursions to points of interest to botanists. On the afternoon of August 12, provided with footware suitable for wading, they will visit the Sphagnum Marsh on Holland River, 33 miles north of Toronto, returning to Toronto late in the evening.

The following sectional excursions will take place after the meeting:

A party of geologists, limited to twenty-four, will leave for northern Ontario on the evening of August 14 in a special Pullman car, and will spend the following five days at Temagami, Cobalt, Kirkland Lake, and the Porcupine district. Those geologists who are going on the western excursion will join it on August 19. The northern Ontario excursion will be free of any expense, and members taking part in this and the succeeding botanical excursion will be guests of the Provincial Government of Ontario until they join the western excursion.

A party of botanists, limited to twenty-five, will also leave on the evening of August 14 for Temagami, and will proceed to the summer station at Bear Island. This excursion, which will entail no expense to the participants, will join the western excursion at Temagami early on Monday morning.

Members of the Agricultural Section will visit fruit farms in the Niagara district on August 15. They will also visit certain stock farms and the Ontario Agricultural College at Guelph. They will spend the night of August 15 at Guelph and return to Toronto in the afternoon or evening of August 16, in time to join the western excursion.

The Western Excursion.—This excursion, as has already been announced, will journey from Toronto to

Vancouver and return. Two trains, half an hour apart, will leave Toronto on the evening of August 17. The trains will proceed westward by the Canadian National and Temiskaming and Northern Ontario Railways, and return by the main line of the Canadian Pacific Railway in time for those sailing from Montreal or Quebec to catch their steamers on September 4. An opportunity will be afforded to visit mines and concentrators at Cobalt, and the mines and mills at Kirkland Lake and Timmins. A day will be spent at Winnipeg, a half day at Saskatoon. At Saskatoon a meeting of the Chemistry Section will be held at the University of Saskatchewan, and a new chemical laboratory will be formally opened. Another day will be spent in Edmonton, where Sections C and K will hold short meetings at the University of Alberta. A short visit will be made to Jasper Park.

Arrived at Vancouver, members desiring to do so may visit Victoria by steamer. In Vancouver and its vicinity visits will be paid to great saw-mills, salmon canneries, and copper mines, and short technical sessions will be held at the University of British Columbia.

A train will leave Vancouver on August 26 and 27 respectively. The first train will make stops of suitable lengths at Glacier, Lake Louise, and Banff, and the second at Lake Louise and Banff. From Banff eastward the trains will travel half an hour apart, and stops will be made at Calgary, at Fort William, and at Port Arthur, where the grain elevators will be visited. The trains will also stop at Sudbury, where the mines and smelters of the famous Sudbury nickel region will be the last important feature to be studied.

As has been already announced, the expense for this excursion, including sleeping accommodation, will be 100 dollars return. Meals will be provided on dining-cars. The local committee is endeavouring to get especially low rates for meals, but it is unfortunately not yet possible to announce what these rates will be.

Appropriate guides with detailed itineraries have been prepared for the western and other excursions, and will be issued at the reception room during the meeting. It is unfortunate that the demand for space on the western excursion has been so great that it will be necessary to limit the number of those participating, who will be chosen from the list of applicants during the meeting. Needless to say, preference will be given to overseas visitors.

Obituary.

SIR SYDNEY RUSSELL-WELLS.

BY the death of Sir Sydney Russell-Wells, which happened with tragic suddenness on Monday, July 14, the cause of education, and especially of university education in London, has suffered a heavy loss. With no outstanding scientific achievements to his name, no published work that could be called noteworthy, the founder of no scientific school of thought, he nevertheless succeeded by dint of courage and perseverance in winning a place of honour as a friend of educational development and as a university administrator.

A Londoner by birth, Sir Sydney Russell-Wells received a sound training in science at the old Royal College of Science and University College, proceeding afterwards to St George's Hospital Medical School, where he had a distinguished career culminating in the passing of the London M.D. in 1895. He held the appointment of Senior Physician at the Seamen's Hospital, Greenwich, and of Physician at the National Heart Hospital. In more recent years, while retaining all his interest in general medicine, he tended towards specialisation in diseases of the heart, and won a reputation as a sound and trustworthy diagnostician.

But it was in the University of London that Sir Sydney Russell-Wells's main interest lay, in the University in which he had graduated in science and in medicine, and which at the time of his death he represented in Parliament and on the General Medical Council. Into the controversies of the University he threw himself in his earlier days with keen interest, with knowledge, and, it must be added, with zest. When, however, an opportunity presented itself of rendering service of a positive, constructive kind, he was not slow to avail himself of it. To him more than to any one is due the existence of the School of Commerce in the University, and to him the recognition, tardy but generous, on the part of the City of London of the fact that there was a great University in London. When in 1920 he was elected Vice-Chancellor of the University, he set himself deliberately to the task of impressing the University upon London, and there is no doubt as to his success. His methods were perhaps open to criticism at times, especially among some of the older members of the University, but no one doubted his zeal and energy, his passionate faith in the future of the University, and his jealousy for its rights and prerogatives.

Sir Sydney Russell-Wells's tenure of the office of Vice-Chancellor lasted nearly three years, and the occupancy of the post undoubtedly broadened his experience and enlarged his outlook. He had been a doughty exponent of the claims of the external student, and while he held consistently to the view that the University merely as an examining body was an agency for good, closer acquaintance with its teaching work, which during his Vice-Chancellorship had enormously expanded, filled him with enthusiasm, and he never ceased to play the part of reconciler between opposing schools of thought. He was also largely responsible for the difficult and intricate negotiations which led to the acceptance of the Bloomsbury site for the University. Much of his work was accomplished under great difficulties, for although he was a skilful and well-informed conversationalist and most persuasive talker, he had no gifts of oratory, and his health, never strong, was taxed severely by the strain he put upon himself. But he kept grimly on, knowing, as he must have known, that he would have to pay the price. He died at his work, and his devotion to it and to his University will be long remembered by his friends and his colleagues.

AT the moment of going to press, we learn with much regret of the death in London on Monday night, July 21, of Sir William A. Herdman, emeritus professor of natural history in the University of Liverpool and president in 1920 of the British Association.

Current Topics and Events.

A SOCIETY for Cultural Relations between the peoples of the British Commonwealth and the Union of Socialist Soviet Republics has been founded recently in London. The objects of the Society are: (1) To collect and diffuse information in both countries on developments in science, education, philosophy, art, literature, and social and economic life; (2) To organise lectures and an interchange of lecturers, conferences, exhibitions, etc., and to arrange for the publication and translation of papers and books; (3) To provide opportunities for social intercourse; (4) To take any action deemed desirable to forward the intellectual and technical progress of both peoples. Russia has unfortunately been cut off from all other civilised countries for about ten years, owing to the War and the revolution which followed it. Only in this year has it been possible to break down some of the wall separating Russia from other peoples. Through the crevices Europe begins to see that, in spite of the most difficult conditions prevailing in science and art, the great spirit of Russia is still alive and even active. Hunger, shortage of necessary technical materials, apparatus and books, the necessity of working in rooms and laboratories where the temperature in winter was near freezing-point, prosecution by the Government—all this has not killed the spirit of Russia. The attempts of the Government to proletarise science and art have not been very successful for a simple reason, namely, there is only one truth, the same for proletarians and bourgeois, the desire for which is that peculiar feature which distinguishes a man from an animal. For Russians the breaking down of the wall surrounding their country has become much more important than for countries which are outside this wall: the development of western science, art, literature, philosophy, and social life, which is free and not "controlled" by Government and has proceeded under normal conditions of life, has resulted in remarkable progress. There is no need to point out how vital the knowledge of this progress is to Russia. From this point of view, it is necessary only to wish all success to this new society, provided it does not become an official organisation, but remains free from any official control and concerns itself only with the promotion of friendly relations between the intellectual representatives of both countries.

BY the retirement, after fifty years of service, of Dr. H. J. H. Fenton, who went to Cambridge in 1874 as an undergraduate of Christ's College, the University has lost a well-known personality and the Chemical Department a distinguished man of science. Dr. Fenton has taken part in the development of chemistry in the University from its infancy, since he became junior demonstrator, under Prof. Liveing, some years before the new laboratories, the nucleus of the existing buildings, were completed and occupied in 1888. In 1886 Fenton published an investigation on the hydration of ammonium carbamate to ammonium carbonate in aqueous solution, in the course of which he employed a novel method of analysis depending upon the fact that sodium hypochlorite sets free only the ammonia nitrogen, whilst sodium hypobromite liberates the amide nitrogen as well. In 1894 he began a fruitful series of researches on the oxidation of hydroxy-acids by hydrogen peroxide in the presence of traces of ferrous iron as catalyst. At an early stage of this work he prepared from tartaric acid the interesting compound dihydroxymaleic acid, and by heating it with pyridine obtained the simplest sugar, glycollic aldehyde. In 1899 Fenton and Miss Gostling discovered the chloro- and bromo-methyl furfuraldehydes, which they obtained by treating ketohexoses or cellulose with the corresponding halogen hydrides. Apart from their intrinsic interest, these compounds formed the basis of new colour tests for certain classes of compounds; *e.g.* by treating bromomethylfurfuraldehyde with malonic ester in the presence of alcoholic potash a fluorescent material was produced, which Fenton showed could be employed to distinguish hexoses from pentoses. Another interesting substance, termed by Fenton methylfuril, gave colour-reactions with primary amines and carbamides. Readers of Fenton's "Outlines of Chemistry" and of his more elementary "Physical Chemistry for Schools" will obtain some idea of the scope of the material which formed the basis of his lectures, but only those who followed the lectures were aware of the masterly treatment of the subject. His "Notes on Qualitative Analysis" constitute the *vade mecum* for thousands of students of that particular branch of practical chemistry.

AN exhibition is now being held in the Assyrian Basement of the British Museum of some of the objects found by the Joint Expedition of the Museum and the University Museum of Philadelphia to Mesopotamia during 1923–24. The principal objects now shown were found around the Temple platform at Tell el-Obeid about five miles from Ur. Of these, the most important, from the historical point of view, is the marble foundation tablet bearing the hitherto unknown name of King A-an-ni-pad-da of the First Dynasty of Ur, which dates back to before 3000 B.C. The exhibit includes a pictorial representation by Mr. C. L. Woolley of the walls and entrance of the temple as they stood originally. This enables visitors to appreciate the significance of the remarkable collections of models of animals and the friezes in bas-relief which adorned the walls with representations of animals and scenes of agricultural life. A wonderful copper statue of a bull some 2 ft. 4 in. high and 2 ft. 8 in. long is undoubtedly the oldest hollow statue now known to exist. It reveals a remarkably high technique for so early a date. It was made by carving the body and limbs in wood separately, and fastening them together with copper wire. Thin copper sheets were then hammered over the whole. The exhibition includes several examples of the use of different coloured *tesseræ* inlaid in bitumen for decorative purposes. The collection will be on view for about two months before it is apportioned to the British Museum, Philadelphia and Baghdad.

THE Natural History Branch of the British Museum, which started its series of picture post-cards not long ago, has gone ahead with them rapidly. Some beautiful examples in colour have been produced by Messrs. Stone, Waterlow and Sons, and W. F. Sedgwick. Of these, 70 cards illustrate insects, 10 birds, 5 reptiles, and 15 plants; and 20 cards represent 122 eggs of British birds. The monochrome series comprises 20 views of the building, 90 mammals, 35 birds, 40 insects, 25 plants, 60 fossils, 15 meteorites, 15 reptiles, 10 corals and sponges, and 10 rare and curious natural history books. Among recent additions, those in colour of British flowering plants promise to be as useful as they are attractive; each shows a plant or spray in flower, a single flower, fruit, and sections; they are made from drawings, but the name of the artist is not given. There are three sets of very life-like reptiles and batrachians, presumably from exhibited specimens. Miss Alice B. Woodward, who worked under the guidance of the late C. W. Andrews, has contributed six characteristic reconstructions of extinct mammals, mainly Proboscidea. New ground is broken by a set illustrating the life history of the common eel, based on the memoir and photographs by Dr. Johs. Schmidt. The educational value of all these cards is considerable, and teaching establishments not already acquainted with them should write to the Director for the latest list.

THE statement of activities of the National Research Council of the United States for the year ending June 30, 1923, is now issued as Circular 49 of the Council. It appears that the Council now derives the whole of its finances from other than Government sources, and is in consequence entirely controlled by its own chosen officers. Its budget for the year was half a million dollars, and in addition it is spending one and a third million dollars on the new building at Washington to accommodate the Academy and the Council, described in NATURE of July 22, 1922, p. 120, and June 28, 1924, p. 940. It maintains about 100 post-doctorate research fellowships in physics, chemistry, biology and medicine from funds derived from the Rockefeller Foundation. Under its sponsorship a considerable number of special organisations carry on research on physical, engineering, chemical, geological, biological, anthropological, psychological and medical questions, such as the structure of the atom, research chemicals, petroleum, sex problems, immigration, food and nutrition. There can be no doubt as to the determination of the people of the United States to make their country a great centre for research, nor as to the energy with which they are carrying out their intention.

IN his presidential address to the Society of Chemical Industry, delivered on July 9 in Liverpool, Dr. E. F. Armstrong referred to the success of the chemical exhibits at the British Empire Exhibition, of the chemical literature which has been issued in connexion therewith, and of the Bureau of Chemical Abstracts, which has been formed to prevent overlapping in the abstracts that are issued by the Chemical Society and the Society of Chemical Industry. On the other hand, he deplored recent signs of increasing competition between the various chemical societies, and the inaction of the Federal Council for Pure and Applied Chemistry in regard to the further consolidation of chemical interests and the establishment of a central Chemistry House. The greater part of the address consisted of a dissertation on the fats, written in collaboration with Mr. John Allan, which gives an excellent survey of existing knowledge and problems in this important field, and would be still more valuable if it had been published with full references to the original literature.

A MARKED degree of success appears to have attended the tests of wireless reception and transmission to and from a moving train carried out by the Radio Society of Great Britain on July 4. An experimental apparatus both for sending and receiving was installed on the express train leaving King's Cross at 7·38 P.M. for Newcastle, and signals transmitted from the train were received at distances of more than 200 miles. Observers in London could hear the signals distinctly while the train was approaching Newcastle (268 miles from King's Cross), and reception was reported from localities so far distant from the line as Shrewsbury and Glasgow. In spite of the deafening noise of the train, and other difficulties, the receiving apparatus worked satisfactorily, and those on the train were in touch with the transmitting station of the Society at Shepherd's Bush, London, while the train was passing through Darlington at 65 miles per hour. An experimental station at Bedford was kept in touch with for more than 150 miles. The complete analysis of the results is not yet available, but enough has been done to show that wireless communication with moving trains is a practical proposition.

THE Southend-on-Sea Public Museum (Prittlewell Priory) has just been enriched by the gift by Major Weber of the Hoy collection of birds (1797–1839). With one or two exceptions the Hoy collection is complete and consists of more than 260 cases. Most of the birds were taken in Essex, Suffolk, and Norfolk, and the collection contains many rare and valuable specimens. Among these are the first recorded British specimen of the pectoral sandpiper, bustards, ospreys, and eagles. The Southend Museum contains also the Christopher Parsons collection of birds (1807–1882) from south-east Essex, and since the Museum was opened in 1922 many rare bird visitors to the county have been secured by purchase, these including the first specimen of the yellowshank recorded in the eastern counties and the third in Britain; the smew; blue-headed wagtail; and numerous other birds. Major Weber's gift, added to the existing collection, makes the ornithological department of the Museum noteworthy among collections of local birds in Great Britain.

IN the seventh Trueman Wood Lecture delivered before the Royal Society of Arts on May 21 and just published in the Society's Journal, Sir William Pope spoke on "The Outlook in Chemistry," and gave a lucid exposition of recent progress in the field of atomic structure, valency, and crystal structure.

He referred particularly to the necessity of altering the methods of teaching chemistry which seems to result from this recent work. It was suggested that a preliminary account of the manner in which all the specialised parts of chemistry fit into the general scheme of the electronic structure of matter and energy should be given. The suggestion was also made that progress in chemical discovery would be more rapid if organised research on specific problems were undertaken rather than individual work.

A FEW days ago the British Cast Iron Research Association formally took possession of its own Laboratories, in Guildford Street, Birmingham, which have been equipped for the conduct of chemical analyses and general metallurgical and heat treatment work. The capacity of the Association to deal with its work will thus be greatly increased, but it is not intended to abandon the policy of having investigations conducted in university laboratories and in the works of members. It is anticipated that the Association, which commenced a new financial year on July 1, will incur an expenditure during the year of between 6000*l.* and 7000*l.* The research programme includes investigations on erosion- and corrosion-resisting and other special cast irons; moulding sands; graphitisation; cupola practice; standardisation of test bars, materials and methods; facing sands and blackings, and cast iron to resist abrasive wear, and jointly with the British Motor and Allied Manufacturers' Research Association, automobile cylinders and pistons.

REFERENCE has already been made (May 24, p. 756) to the valuable "Handbook to the Exhibition of Pure Science" prepared by a committee of the Royal Society in connexion with the exhibits arranged by it in the Government Pavilion at Wembley. The Handbook contains, in addition to descriptions of the exhibits, a most instructive series of twenty-two articles by leading authorities upon current scientific work and problems, and every student of science should possess a copy of it. We are glad to know that arrangements have been made for its sale outside the Exhibition through Messrs. A. and F. Denny, Ltd., 163A Strand, London, W.C.2, who can supply the Handbook direct or through booksellers. The price is 1*s.*, or post free 1*s.* 3*d.*; and as the book contains 228 pages it is remarkably cheap, as well as superior to many volumes published at a much higher price, whether intended for the general public interested in science or for students in school or college.

THE annual field day at the National Fruit and Cider Institute of the University of Bristol, Long Ashton, was held on Tuesday, July 15, and was attended by a representative gathering of agriculturists and horticulturists from all parts of the West of England and even farther afield. Among those present were Lord Bledisloe, chairman of the Governing Body of the Station, and Mr. W. G. Lobjoit, Controller of Horticulture, representing the Ministry of Agriculture and Fisheries. The visitors were first given the opportunity of sampling the ciders produced during the last two seasons in the course of the Station's experimental work on cider making. These were exhibited in the new wing recently added to the cider house. The variation in the quality of ciders due to seasonal influences was markedly illustrated by comparing ciders made in 1922 and 1923 from some of the more famous vintage varieties of apples, such as Kingston Black, Cap of Liberty, and Foxwhelp, the advantage being definitely in favour of the 1922 vintage. Among other interesting features illustrated by the ciders were the effects of storage of the fruit under various conditions prior to cidermaking, the results of natural fermentation of the juice as compared with fermentation of pasteurised juice by specially selected yeasts, and the different degrees of control of fermentation obtainable by methods of racking and filtration. After sampling the ciders the visitors were conducted through the fruit plantations to inspect the various features of the experiments at present in progress. The attention of the parties was directed by guides to the numerous field investigations in progress on many subjects of importance to the fruit-growing industry.

MR. R. M. STEWART, assistant director of the Dominion Observatory at Ottawa, has been appointed director of the Observatory in succession to Dr. O. Klotz, who died in December last.

WE learn that the Radio Society of Great Britain is in touch with the Postmaster-General regarding the restrictions as regards transmissions to the dominions and foreign countries recently introduced into the experimental transmitting licences now being issued. It is hoped that an official announcement may be made at an early date.

AT the annual general meeting of the Faraday Society held on July 7, Prof. F. G. Donnan was elected to succeed Sir Robert Robertson as president. The annual report records considerable activity during the past year, the result of which is reflected in the accounts which show a deficit of 109*l.* 11*s.* 5*d.* on the year's work. Eleven meetings were held during the year, and of these four were general discussions, which have become so striking a feature of the work of the Society. The subjects of these were: (i.) "Alloys Resistant to Corrosion." (ii.) "The Physical Chemistry of the Photographic Process." (iii.) "The Electronic Theory of Valency." (iv.) "Electrode Reactions and Equilibria." The widespread appreciation in which the publications of the Society are held is indicated in the fact that the sales of Transactions and reprints amounted to nearly 900*l.*, a figure in excess of the amount received for subscriptions. It is surprising to note that the membership of this very active Society is only 432, and that consequently an appeal for a larger membership is made in the annual report. Particulars relating to the Society may be obtained from the secretary and editor, Mr. F. S. Spiers, 90 Great Russell Street, London, W.C.1.

IN commenting upon an article in NATURE of July 12 on "Artificial Daylight," a correspondent suggests that

the apparent indifference to daylight lamps is due to their excessively high prices. Our contributor, Dr. Martin, remarks that he has no knowledge of the actual cost of production, but he agrees that the average price appears to be high. Doubtless, however, an increased demand would cheapen production and result in lowered prices. The question is one with the general question of efficient lighting. To take an actual example, there are many days during the winter in which the grading and examination of such things as seeds, tea, tobacco, etc., is very difficult, if not impossible. There is no doubt that time and money are lost in this way for want of an efficient illuminant. The actual cost of a good daylight lamp would be negligible in comparison with the saving effected; that is, if the user trusted his lamp and the customer had been educated to the point of trusting it also.

THE following are among the pensions granted during the year ended March 31, 1924, and payable under the provisions of section 9 (1) of the Civil List Act, 1910: Mrs. C. A. F. Rhys Davids, in recognition of her contributions and those of her husband, the late Prof. Rhys Davids, to the advancement of Pali and Buddhist knowledge, 100*l.*; Mrs. Blanche Hartog, in recognition of the contributions of her husband, the late Prof. Marcus Hartog, to the study of natural history, 50*l.*; Dr. Alice Lee, in recognition of her services to the cause of scientific research, 70*l.*; The Misses Ethel Marian and Katherine Elizabeth Rivers, jointly and to the survivor, in recognition of the services rendered by their brother, the late Dr. W. H. R. Rivers, to the cause of anthropology, physiology, and psychology, 100*l.*; Mrs. M. F. Robertson, in recognition of the services rendered by her husband, the late Dr. W. F. Robertson, to science and medicine, 100*l.*

MR. F. EDWARDS, 83 High Street, Marylebone, has just issued Catalogue No. 460 (British Empire Series, No. 3), containing the titles of upwards of 1100 works relating to India, Burma, Ceylon, Afghanistan, Beluchistan, Malaya, and Borneo. Many of the books listed formerly belonged to the late Dr. W. Crooke, a regular contributor to NATURE.

WE have received Bulletin 212 of the Department of the Interior, Washington, entitled "Analytical Methods for Certain Metals, including Cerium, Thorium, Molybdenum, Tungsten, Radium, Uranium, Vanadium, Titanium, and Zirconium," by R. B. Moore, S. C. Lind, J. W. Marden, J. P. Bonardi, C. W. Davis, and J. E. Conley. The pamphlet is of great value and should be found useful by analysts. Many modern products (*e.g.* special steels) contain these so-called "rare" elements, and rapid and accurate methods for their estimation are required.

Our Astronomical Column.

LARGE FIREBALL.—On July 7, a few minutes after midnight, a splendid meteor was observed at various places. It appeared, however, at a time when few observers were about, and hence we are not likely to receive many accounts of it. The object gave a very vivid illumination for a few seconds and moved very slowly from a radiant very probably in Scorpio. The descriptions already to hand are not, however, sufficiently definite to allow safe deductions to be made from them. From near Dunstable, the flight of the fireball was recorded as from κ Draconis to a little below α Aurigæ. From near Ludgate Hill, London, the meteor appeared as a large ball of fire leaving a trail of white sparks. The nucleus was yellow in the central part and brilliant orange in the outer portion.

Observations of the position of the flight and its duration would be valuable. Large meteors have often been directed from Scorpio in the three months May, June, and July, the radiant point being a few degrees N.E. of the bright red star Antares.

AUGUST PERSEIDS.—This annual display of meteors has already given clear evidence of its activity. Mr. Denning, writing from Bristol, states that he observed an early Perseid this year on June 27, when the radiant was in about 356°+39°. From this point in Andromeda, the shower will move to E.N.E. through the northern region of Perseus and on between the constellations of Auriga and Camelopardalus. This stream of meteors has the longest duration of any known shower and the propriety of terming it "the Perseids" is perhaps questionable seeing that the meteors, during a portion of the shower's activity, diverge from Andromeda and other constellations.

Of late years this shower has formed some attractively abundant displays and notably so in 1921 and 1923. In the former year there was a decided maximum, the horary number reaching 250 for one observer on Aug. 12 A.M. Coulvier-Gravièr, a great French observer of meteors in the first half of the last century, thought that, after a maximum which he observed in 1848, the strength of the display declined so rapidly that it would be extinct by the year 1860. His conclusions were, however, far from being realised, and the shower continues to be visible every year with apparently the same richness as it exhibited in former times.

THE CANADIAN ECLIPSE EXPEDITION TO WALLAL 1922.—C. A. Chant and R. K. Young have just published the details of their investigation of the gravitational bending of starlight made at Wallal (Publications of Dominion Astrophys. Observ., vol. ii. No. 15).

An equatorial was taken, the general design of which is stated to resemble that of the 100-inch at Mt. Wilson. The total weight was about a ton. A guiding telescope of $4\frac{1}{2}$-inch aperture was attached to the camera, β Virginis being used for guiding. Two plates were taken for the Einstein investigation, each with 45 seconds exposure; 20 stars are shown, the magnitudes of which range from 4·3 to 9·5, but the two faintest were not used.

Full details are given of the measurement and reduction. The adopted mean shift at the sun's limb is 1·75″, exactly agreeing with Einstein's value. The separate values for measures in the x and y coordinates are 1·32″, 1·96″.

The results are insufficient to *prove* that the individual shifts follow Einstein's law (shift varies inversely as distance from sun's centre): but they group themselves fairly satisfactorily on either side of the theoretical curve.

The three separate investigations made during this eclipse all give mean results very close to Einstein's value.

Research Items.

ZENITH OF PRIMITIVE BABYLONIAN ASTRONOMY.—Prof. Reginald A. Fessenden, of Chestnut Hill, Mass., whose proposals for an archæological expedition to the Caucasus have received support from archæologists and ethnologists in the United States, including Prof. Clay of Yale, and Dr. A. Hrdlička, writes to ask whether any information is available in regard to a primitive Babylonian zenith fixed at Mt. Bakhar, near Baku. Prof. Fessenden is of the opinion that the zenith of primitive Babylonian astronomy, which goes back to a time when the Accadai (Agadi) had not yet descended from their mountain fastnesses, was fixed in the Caucasus. This area he maintains was the meeting-point of the original Babylonian and Egyptian civilisations. In support of this view he argues that the Book of the Dead was originally written in what Dr. Clay has called "Amuraic"—the early Semitic language—and that when it was translated into Egyptian, place-names were transformed and personal names mistranslated. When corrected in the light of a knowledge of the original tongue, these names reveal that the hidden land of Amen was the Caucasus Isthmus, for the road to which the Book of the Dead gave precise directions. The Egyptians and Colchians would thus be the same race, and the Isthmus the old home-land of the former. At the same time, many of the place-names in the neighbourhood of Mt. Bakhar, which antedate the Russian regime, are Babylonian, *e.g.* Schemacha, Marazi, Agadi-Kend, etc. It is therefore desirable to fix the zenith with some accuracy to determine which sites may be investigated by a preliminary expedition with most profit.

THE BLOW-GUN IN ASSAM.—In view of the frequent identity of culture between the Naga tribes and those of Indonesia, it has seemed rather surprising that while the blow-gun occurs among the latter, it should not have been found in Assam. Its occurrence is now recorded for the first time by Mr. J. H. Hutton in *Man* for July. It is found—as a toy rather than as a weapon—among the Thado Kukis, its principal use being to shoot rats. The darts are not poisoned. A similar toy is used in the Philippines; but the Karens of Burma, who appear to be related to the Nagas, employ the genuine blow-gun. The Thado type does not appear to be a degeneration, but is more probably the original form which in this area never developed. It consists of a single internode of simple bamboo, the maximum length being about two feet. It has an effective range of about twenty feet only, though a mere carry of seventy feet can be attained. Several patterns of dart are in use. In one of these, cotton is employed for the plug, although, it is interesting to note, this material does not occur in the area of distribution in Asia of the genuine weapon.

DIENTAMŒBA FRAGILIS IN A CHILD.—W. H. Taliaferro and E. R. Becker record (*Amer. Journ. Hygiene*, vol. iv., pp. 71-74, 1924) the case of a three-year-old girl, who was born in Baltimore and had never left the state of Maryland, infected with several intestinal protozoa, namely, *Dientamœba fragilis*, *Iodamœba williamsi*, *Endamœba coli*, *Trichomonas hominis* and *Giardia lamblia*. The child had never suffered from any intestinal disorder. Prolonged search failed to reveal any encysted stage of *D. fragilis*. The authors tabulate the 33 previously recorded infections with this species, the distribution of which indicates that, in common with other intestinal amœbæ of man, it is indigenous to the temperate zones as well as to the tropics.

DOUBLE EGGS.—Prof. T. H. Morgan contributes (*Scient. Monthly*, April 1924) a useful account of double eggs—twice as large as those normal for the species—which are supposed to arise from the union of two eggs. They develop into embryos twice as big as normal ones. The occurrence of these giant eggs has led to the attempt to unite two eggs by artificial means and to experiments on the fusion of blastulæ or parts of embryos. Prof. Morgan remarks that the results obtained from the study of fused eggs or embryos have not solved any of the larger problems of development, but have broadened our ideas concerning some of the possibilities of regulation between two systems each alone adjusted to produce only a single individual. He describes the recorded cases of the development of giant eggs of sea-urchins and the opportunity these have afforded for estimating the relative importance of chromatin and protoplasm in the development of hybrid larvæ. These giant eggs, the mode of origin of which is unknown, have a single nucleus with twice the normal number of chromosomes, and when fertilised develop at the normal rate. Large blastulæ and plutei are formed which have the normal number of cells, but the cells are twice the normal size. The normal egg of Sphærechinus contains, according to Baltzer, 20 chromosomes and after fertilisation 40; the fertilised giant egg contains, according to de Haan, 60-63 chromosomes, 40 of which probably come from the egg (diploid) and 20 from the sperm. An account is given of the hybrid plutei produced by fertilising giant eggs of Sphærechinus by sperm of Strongylocentrotus, and the stronger resemblance to the maternal plutei is probably due to the greater influence of the larger number of maternal chromosomes. Double-sized eggs of Ascaris and giant embryos of Lineus and of Triton arising from the fusion of two eggs are described and discussed, and reference is made to the origin of embryos which are not giants, but nevertheless apparently owe their origin to the fusion of two eggs (*e.g.* in a strain of Abraxas).

ICEBERGS IN NORTH ATLANTIC.—A descriptive account of the dangers of ice to vessels traversing the ocean between Europe and America, and the effective means taken to avert the danger, is given by Prof. R. de C. Ward, of Harvard University, in the *Monthly Weather Review* for February. A cruise, lasting fifteen days, was made on the U.S. Coast-guard cutter *Modoc*, on ice patrol duty, and the author being a meteorologist of great experience his communication is greatly enhanced. A memorial service was held at the spot where the *Titanic* sank, after collision with an iceberg in 1912, when 1500 lives were lost. The danger zone is now patrolled day and night during the ice season, the position of menacing bergs is given by radio to all passing ships, and no serious collision with ice has occurred since the patrol was inaugurated, a month after the catastrophe to the *Titanic*. Every vessel passing through the ice region, longitude 43° to 55° W., is expected to send by radio to the patrol vessel information as to any ice sighted. The U.S. Government manages the service, other nations assuming a share of the expense. Most of the bergs come from the fringe of glaciers bordering the west coast of Greenland, east of Baffin Bay, others come from the east coast of Greenland, and some start in Smith Sound. Charts are given showing the general drift of icebergs, and the drift track of an iceberg in the season of 1921 is shown, being traced from April 11 until May 12. Hunting icebergs is the business of the ice patrol, and the commanders of the vessels

employed are highly experienced. Photographs are given of several bergs. Testimony is borne to the splendid work done by officers and men, year after year, amid the dangers of ice, fog, and storm.

THE FATIGUE OF METALS.—Profs. H. F. Moore and T. M. Jasper have just published the third portion of their extensive research into the fatigue of metals as Bulletin No. 142 of the Engineering Experiment Station of the University of Illinois. On re-testing wrought specimens of iron and steel which have been subjected to many millions of stress alternations without failure, it is found that their endurance has been increased, the strengthening effect being greatest in those steels which are most hardened by cold-working. The static strength is also increased. Alternating stress above the endurance limit, on the other hand, weakens the metal, although the bad effect may be partly removed by polishing. Reversed axial stresses give an endurance limit which is only about 64 per cent. of that found by alternating bending tests, but this difference has not always been found by other investigators, and may perhaps be due to the form of test-piece employed. The authors consider that their test-piece represents the conditions likely to occur in the actual running of machines, and therefore recommend the adoption of the lower figure for reversed axial stresses. This recommendation may lead to controversy. Steels give inferior tests across the direction of rolling, as would be expected, and it is interesting to note that the cross tests are more improved by heat treatment than the longitudinal tests. It is doubtful whether soft non-ferrous metals and alloys have an endurance limit, and in order to determine this point it will be necessary to continue the tests for hundreds of millions of cycles. The authors take the view that fatigue failures do not take place by slip, but by the tearing apart of minute portions of crystals and spreading of the fissures so formed.

FIBROUS STRUCTURE IN METALLIC ELECTROLYTIC DEPOSITS.—Messrs. R. Glocke and E. Kaupp have recently carried out an X-ray examination of electrolytically deposited metals, which they describe in the *Zeitschrift für Physik* for May. They find it advantageous to use homogeneous radiations of medium wave length, the best results being produced by using an anticathode made of a metal closely following silver in the periodic system, the natural radiation of which excites the silver radiation of the photographic granules. An alloy of antimony and nickel (63 : 33), which melts at 1158°, a temperature nearly twice as high as the melting-point of pure antimony, was experimented with, and appears to be suitable; but the actual measurements were made with a silver anticathode. X-ray photographs were taken in a number of different directions through the material used, and showed that, in many cases, there was a distinct fibrous arrangement of the crystals. The axis of the elongated crystalline "fibres" is in the [011] direction in the case of copper, in the [111] or [112] direction for iron, [001] for nickel and [112] for chromium. In all cases this axis is identical with the direction of the electrolysing current, or perpendicular to the cathode surface. The crystallographic direction of the axis of the fibres depends on the composition of the solution; and, with some solutions, there is no fibrous structure, but the crystals are small and granular. It appears that the fibre axis is the direction of maximum growth velocity of the particular crystal in the electrolyte concerned. The nature of the cathode influences the structure, which is most perfectly fibrous when the cathode and the deposit are of the same metal.

DRY COOLING OF COKE IN GASWORKS PRACTICE.—Hot coke drawn from gasworks retorts is customarily cooled by contact with a stream or spray of water. At the newly erected Garston works of the Liverpool Gas Company the Sulzer system of dry cooling, now in operation at some continental works, has been tentatively applied to the coke derived from a bed of ten retorts, and the results were described at the annual meeting of the Institution of Gas Engineers. The coke so cooled is superior in appearance, higher in calorific power, and burns more freely in an open fireplace than that produced by wet quenching. The increased cost of dry cooling amounts to about 1*s.* 3½*d.* per ton of coke. Economic considerations indicate that the sale of dry coke is a sound commercial proposition provided the consumer realises the superior value of the dry fuel.

CHEMISTRY OF FATS.—A large part of the presidential address delivered by Dr. E. F. Armstrong to the Society of Chemical Industry on July 9 in Liverpool was a joint communication with Mr. John Allan dealing with our present knowledge of fats. After dealing with the composition and constitution of the natural glycerides, the authors emphasise the need for further research on the separation of certain fats which resemble one another closely in chemical composition, but differ widely in physical properties. They describe fully how the fatty acids are distributed in Nature, and indicate their possible modes of formation. They think that fats may be synthesised in plants and in animals from carbohydrates, of which the unit is one containing 18 carbon atoms in its molecule. Milk fats and certain nut oils may be built up from a simpler carbohydrate, like dextrose, the contained acids being synthesised from one another by repeated aldol condensations; and a third possible mode of synthesis is by resolution of dextrose into a C_3-unit and condensation of such units to form acids containing 12 or 18 carbon atoms.

SYNTHESIS OF METHANE FROM WATER GAS.—From work carried out in the laboratories of the South Metropolitan Gas Company and communicated to the annual meeting of the Institution of Gas Engineers, it appears that the reaction velocity of the synthesis of methane from water gas at 290° C. is increased about seventeenfold by the use of an activated catalyst, namely nickel-thoria, in place of nickel. The technical application of the process requires practically complete removal of sulphur compounds from the water gas employed, as it is found that one part of sulphur per million parts of gas effectively poisons the catalyst. Such removal and the necessary adjustment of the hydrogen to carbon monoxide ratio in the water gas can be effected smoothly and rapidly at temperatures industrially applicable, namely, about 550° C., by the passage of water gas and steam over a catalyst consisting of iron activated by chromium oxide deposited on five times its weight of pumice. Excluding the cost of this hydrogenation process, it is estimated that the net cost of production of a synthetic gas of approximate composition CH_4, 64 per cent.; H_2, 24 per cent.; N_2 12 per cent., and of calorific power 690 B.Th.U. per cubic foot, would be 10·9*d.* per therm. The cost of removing carbon dioxide appears to be the deciding factor as regards the possible establishment of the process on an industrial scale. (Cf. NATURE, June 9, 1923, vol. 111, p. 779.)

The Toronto Meeting of the British Association.

PROVISIONAL PROGRAMMES OF SECTIONS.

PROVISIONAL programmes of the Sections of the British Association for the Toronto meeting on August 6-13 have now been arranged, from which it appears that those who attend the meeting will be very fully occupied. The meeting will be noteworthy for the number of American and Canadian men of science who are presenting papers and taking part in many of the joint discussions.

We are indebted to the Recorders of the Sections for the following brief statements of important features of the work of the various Sections.

SECTION A (MATHEMATICS AND PHYSICS).

The outstanding feature of an extensive programme is the discussion which has been arranged, jointly with Section B, on crystal structure. The presidential address which Sir William Bragg will deliver on "The Analysis of Crystal Structure by X-rays" will form the introduction to this discussion, to which, among others, Prof. W. L. Bragg, Prof. S. Chapman, Dr. Shearer, Prof. Desch, and, possibly, Prof. Siegbahn (of Upsala) will contribute.

The exceptional equipment of the Toronto physical laboratory lends special interest to the paper promised by Prof. McLennan on "Recent Developments in Low Temperature Research," because the liquefaction of helium and the luminescence of solid nitrogen will be demonstrated. The United States, as well as Britain and Canada, will be well represented in the programme; the papers by Drs. Mohler and Foote on "Critical Potentials and their Interpretation," Prof. A. H. Compton on "The Quantum Theory of the Scattering of X-rays," Prof. Duane on "Secondary and Tertiary Radiation," and one by Prof. R. W. Wood may be mentioned.

Among the visitors to Canada, Prof. A. Fowler will read a paper on "The Spectra of Ionised Elements," Mr. R. H. Fowler will deal with "Mechanisms of Excitation, Ionisation, and Dissociation in Statistical Theory," and Prof. C. V. Raman will take a principal part in a discussion of the scattering of light.

There are many meteorological and geophysical papers promised, and the Section will have to subdivide in order to deal with them. Sir Napier Shaw has chosen the subject "If the Earth went Dry," and Mr. F. J. W. Whipple and Mr. L. F. Richardson, who are also going from England, will read papers. Canada itself is providing a number of meteorological papers; Sir Frederic Stupart, the Director of the Canadian Meteorological Office, has given as his subject "The Variableness of Canadian Winters." Astronomy will occupy a whole morning; papers are expected from Prof. Eddington on "Theory of Outflow of Radiation from a Star," Dr. H. H. Plaskett on "The Spectra of Nebulæ," and Dr. Silberstein on "Determination of the Curvature Radius of Space-time."

A special feature is being made of afternoon sectional lectures, of which there will be no less than three, and those of exceptional interest. Sir Ernest Rutherford will lecture on "Atomic Disintegration," Sir Richard Paget on "The Nature of Speech," and Prof. V. Bjerknes (of Bergen) on "The Forces which lift Aeroplanes." The last two will be illustrated by experiments. It is hoped to arrange short sessions of the Section at Saskatoon and Edmonton during the transcontinental excursion following the Toronto meeting. Sir Richard Paget has promised to lecture at both places.

SECTION B (CHEMISTRY).

Chemistry will be represented by a good attendance from Great Britain, and interesting meetings are expected. The president, Sir Robert Robertson, has selected "Chemistry and the State" as the subject of his address, and he will also deliver a lecture on explosives. The Section will join with Section A (Mathematics and Physics) in a discussion on crystal structure, and with Section I (Physiology) in one on vitamins, particulars of which will be found under the programmes of those sections. A morning will be devoted to a discussion on electrochemical industries, with special reference to Canada, Mr. H. Freeman dealing with Canadian hydro-electric development, Mr. D. A. Pritchard with the Canadian Salt Co.'s processes, Mr. R. L. Peek with electrolytic nickel, Mr. F. A. J. Fitzgerald with a radiant resistor furnace, and other contributors being Mr. F. A. Lidbury and Prof. F. G. Donnan.

Section C (Geology) will join in a discussion on liquid and powdered fuels, Dr. G. S. Hume reviewing the liquid fuels of Canada, Prof. G. A. Guess describing the use of powdered fuel in metallurgical plants, and Prof. W. A. Bone that of Canadian lignites. In another session, Prof. Bone will deal with the activation of nitrogen in explosions. An important discussion, in which Section A will join, is that on colloids, which will be opened by Prof. J. W. McBain with a group of papers dealing mainly with soaps, whilst Prof. W. D. Bancroft will speak on the permeability of membranes, Prof. E. F. Burton on the mutual action of electrically charged particles in solution, Prof. W. Lash Miller on the distribution of colloidal gold between two liquid phases, Prof. F. B. Kenrick on colloids in distilled water, and Prof. H. S. Taylor on adsorption from silver salt solutions by silver iodide. Visits to electrochemical works are being arranged.

SECTION C (GEOLOGY).

Ontario, one of the most important mineral-producing areas in the world, must of necessity be intensely interested in geological problems, and no gathering of men of science there could possibly avoid devoting considerable attention to that branch of science. While general topics are of interest in any or all circumstances, the industrial applications of geological knowledge are of paramount importance here. In addition, it is not without advantage that the problems confronting geologists and mining men in Canada are largely connected with the most ancient rocks of which we have any knowledge. Consequently the programme of Section C has been designed to stimulate, so far as possible, interest in both pure and applied geological science. The president, Prof. W. W. Watts, has selected as the subject of his address "Geology in the Service of Man," while subsequent speakers will emphasise particular aspects of applied geology as evidenced in Canada, and more especially in Northern Ontario. Inextricably bound up with the practical side of geology in Canada are the various problems connected with Pre-Cambrian rocks (indeed the word Pre-Cambrian is almost a household word in Ontario), and a whole session will be devoted to consideration of problems associated with these rocks in many parts of the world.

Appealing more strongly perhaps to another group of the public will be the joint discussion with the geographical section on changes of sea-level in relation to glaciation, coast-lines, etc., while a third on liquid and powdered fuels has been arranged as a joint discussion with Section B (Chemistry). This latter has had to be fixed to run concurrently with another meeting as the time available will not suffice for all the activities of the Section.

While such questions of general interest will occupy a considerable part of the sessions, the results of recent research work on more special subjects will be expounded by many authors. Mineralogy, petrology, palæontology, and stratigraphical geology will all be represented, so that every branch of geological interest will have its exponents.

As is usual in the case of Section C, excursions to places of interest round Toronto will form an important part of the programme. Three such excursions have already been settled, one being a week-end trip to the Niagara and Grimsby districts. Others will probably be fixed during the meeting, and members are advised to consult the notice boards outside the sectional rooms from time to time. On the western trip following the meeting, opportunities will be given for geologists to examine selected areas *en route*, but such areas must of necessity be determined by factors not entirely geological.

SECTION E (GEOGRAPHY).

The address by the sectional president, Prof. J. W. Gregory, will deal with "Inter-Racial Problems and White Colonisation in the Tropics." Another paper on allied problems will be on "Immigration from a Biological Point of View" by Dr. H. H. Laughlin. Many of the papers will treat of various aspects of Canadian geography, including Dr. Bell Dawson on "Tides and Currents in Canadian Waters," and Mr. E. M. Dennis, Mr. W. H. Boyd, Mr. N. Ogilvie, and Mr. W. H. Herbert on different branches of the work of the topographical survey of Canada. Dr. R. M. Anderson will speak on the status and prospects of the larger mammals of Canada.

Papers dealing with cartography and allied problems will be given by Mr. I. Bartholomew on modern developments in the construction of maps and Mr. J. B. Reynolds on the work of the Permanent Committee on Place-Names. Important papers in physical geography include "Wind, Wave, and Swell in the North Atlantic" by Dr. Vaughan Cornish, "Classification of Oceanic Islands" by Prof. W. M. Davis, and "The Glacial Anticyclone" by Prof. W. H. Hobbs. Prof. P. M. Roxby will lecture on the distribution of population in China, and Mr. Cuthbert Christy on Cape to Cairo progress.

Papers in human geography also include one on some aspects of urban growth by Mr. H. L. Seymour, and another on the influence of geographic conditions on the ancient Mediterranean religions by Miss E. C. Semple. Miss M. I. Newbigin's paper on the training of the geographer should direct attention to the notable lack of such facilities in Canada.

SECTION F (ECONOMIC SCIENCE AND STATISTICS).

The programme for the Economics Section at the Toronto meeting covers a wide and important field. Sir William Ashley's presidential address is "A Retrospect of Free Trade Doctrine." Business forecasting will be discussed by Prof. W. N. Persons, Mr. R. H. Coates, Prof. Mitchell, and Prof. H. W. Mackintosh.

The problem of population is to be dealt with in four papers from different points of view; Sir William Beveridge dealing with the fall of human fertility among the European races, and some of its reactions, Mr. Udny Yule with the population problem from the point of view of the Pearl and Reed law of growth, Prof. MacIver with civilisation and population, and Prof. Field with eugenic worth and economic value. Prof. J. E. Boyle is contributing a paper on the marketing of grain, and a film is to be shown illustrating the marketing of wheat. A discussion is to be held jointly with the Agriculture Section on diminishing returns in agriculture, and papers are to be read by Prof. C. R. Fay and Sir John Russell. Prof. A. L. Bowley will read a paper on the economic outlook in Great Britain, and the problem of unemployment prevention and insurance is to be discussed in papers by Prof. J. R. Commons and Mr. Bryce M. Stewart.

The meetings of the section will, therefore, bring together many of the leading economists of Great Britain, Canada, and the United States.

SECTION G (ENGINEERING).

The programme of the Section opens with Prof. G. W. O. Howe's presidential address entitled "One Hundred Years of Electrical Engineering." The remaining papers to be presented fall practically into two big groups: Canadian engineering problems and the strength of materials.

The first group is to be opened by Sir Henry Thornton, president of the Canadian National Railways, who will discuss railway transportation in Canada. This will be followed by a paper from Lieut.-Col. H. S. Lamb on engineering problems and traffic on the Great Lakes. Mr. J. B. Challies, director of the Water-Power and Reclamation Service, is to deal with the water-power resources of Canada. Water-power development commenced in 1895, and its possibilities may be envisaged from the fact that during the past ten years, while the population has increased 22 per cent., the water-power in use has increased nearly 100 per cent., and its use in industry 245 per cent. The total water-power of the Dominion is estimated at 18,000,000 horse-power, of which nearly 3,250,000 horse-power has been developed and 750,000 is under construction. The story will be taken up by Mr. F. A. Gaby, chief engineer of the Ontario Hydro-Electric, who will deal with the Hydro-Electric Power Commission of Ontario, and by Mr. R. S. Lea, who will discuss the possibilities of power development of the St. Lawrence River. A visit to the Niagara Fall Power Houses will be an appropriate conclusion to this part of the Section's work.

The second part of the programme will be opened by Prof. E. G. Coker with Mr. A. L. Kimball, of the General Electrical Company, Schenectady, who will describe American experiments on the optical determination of stress. Profs. H. F. Moore and T. M. Jasper, of Illinois University, will discuss the evidence for the existence of an endurance limit in metals, Prof. F. C. Lea, the effect of high temperature on the range of repetition stress for steels, and there are several other papers on related topics. The whole subject may be expected to be dealt with in two reports to be presented to the Section, one by Prof. C. F. Jenkin, on the work of the Fatigue Panel of the Aeronautical Research Committee, and another on the work of the Complex Stress Committee.

Other subjects to be dealt with by the Section include questions of public health (Mr. F. A. Dallyn), bio-aeration in sewage disposal (Mr. J. D. Watson), cobalt magnetic steels (Mr. E. A. Watson), and the future of power from fuel (Mr. E. K. Scott).

SECTION H (ANTHROPOLOGY).

Communications by anthropologists from Canada and the United States provide the greater part of the programme of the Section. Dr. F. C. Shrubsall's presidential address is entitled "Health and Physique through the Centuries." Other British contributions will include papers by Dr. A. C. Haddon on "A Suggested Arrangement of the Races of Man"; Dr. T. Ashby on "Recent Archæological Discoveries in Italy"; Mr. H. Balfour on "The Welfare of Primitive

Peoples," and also on "The Art of Stencilling in the Fiji Islands"; Mr. L. H. Dudley Buxton on "Skulls from the Valley of Mexico," and on "Physical Observations on Navajo Children." Prof. H. J. Rose's paper, "The Bride of Hades," will deal with virgin sacrifice as a fertility rite in early Greece and Rome.

Of communications by Canadian anthropologists, a number will deal with work which has been done under the Anthropological Department of the Geological Survey. Mr. Jenness deals with "The Ancient Education of a Carrier Indian"; Mr. T. F. McIlwraith with "The Potlach in Bella Coola," the result of a personal and, possibly, a unique experience; Miss E. G. Spier will analyse the "Ceremony of the First Salmon," and Mr. G. E. Rhoades will discuss "Composition in the Art of the North-west Coast Indians." From the United States Dr. A. Hrdlička will discuss the antiquity of man in America in the light of recent discoveries, with special reference to the skeletal remains recently found at Los Angeles. Mr. B. Oetteking also will give an account of the Santa Barbara skeletal remains; and Mr. Harlan I. Smith will describe "Trephined Aboriginal Skulls from Columbia and Washington." Dr. C. Wissler will deal with "The Segregation of Racial Characters in a Population," and Dr. Laughlin, of the Statistical Bureau, New York, will give an account of some racial characters emerging from the data obtained from immigrants. A joint discussion with Section J (Psychology) on "Racial Mental Differences" will be opened by Prof. W. McDougall.

Section I (Physiology).

The provisional programme arranged for the Section is the largest there has been for many years. It contains more than forty communications, covering a very wide range of subjects in physiology, biochemistry, and practical applications of these subjects to medicine.

The proceedings of the Section will open with the address of its president, Dr. H. H. Dale, on "Progress and Prospects in Chemotherapy." There are two joint discussions on the programme, one with Section B (Chemistry) and one with Section J (Psychology). The joint discussion with Section J will be on "Physiological and Psychological Factors of Muscular Efficiency in Industry," and will comprise the following papers among others: Prof. C. Lovatt Evans, "The Physiology of Muscular Contraction in Relation to Efficiency and Fatigue"; Prof. E. A. Bott, "Co-ordinate Volitional Action of Antagonistic Muscular Groups"; Prof. E. P. Cathcart, "Energy Exchange in Relation to Muscular Performance in Laboratory Investigations"; Prof. C. S. Myers, "Conceptions of Fatigue," and Prof. F. S. Lee, "Physical and Chemical Tests for Fatigue."

The joint discussion with the Chemistry Section will be entitled "Vitamins, and the Relation of Light to their Action," and the following are included in the papers to be contributed to it: Prof. J. C. Drummond, "Modern Tendencies of Vitamin Research"; Prof. H. C. Sherman, "The Quantitative Distribution and Nutritional Significance of Fat-soluble Vitamin"; Prof. Walter H. Eddy, "The Isolation of a Bios from Autolysed Yeast"; Prof. E. Mellanby (title not given); Prof. W. Lash Miller, "Bios"; and Prof. W. Steenbock, "Radiant Energy as the Anti-rachitic Factor."

Meeting at Toronto, it is appropriate that the Section should hear something of insulin, and Prof. J. J. R. Macleod and Mr. C. H. Best are, among others, dealing with this interesting subject.

Prof. J. C. Drummond is to deliver a popular lecture on "Cod-liver Oil."

There will be a large number of United States visitors at the Physiology Section.

Section J (Psychology).

The papers this year are so diverse in character that it is difficult to group them all under a few general headings. The presidential address by Prof. W. McDougall is entitled "Purposive Striving as a Fundamental Category in Psychology."

Three joint discussions have been arranged: (*a*) With Section H (Anthropology), on "Racial Mental Differences." *Speakers*—Prof. W. McDougall, Dr. C. S. Myers, and others. (*b*) With Section I (Physiology), on "Physiological and Psychological Factors of Muscular Efficiency in Industry." *Speakers*—Prof. Lovatt Evans, Prof. E. A. Bott, Prof. E. P. Cathcart, Dr. C. S. Myers, Prof. F. S. Lee. (*c*) With Section L (Education), on "Tests for Scholarships and Promotion." *Speakers*—Principal E. Barker, Prof. C. Burt, Prof. Sandiford, Prof. Whipple, and Prof. Buckingham.

A welcome feature of the programme is the important contributions of American and Canadian psychologists; for example, "The Problem of Personality," by Dr. Morton Prince, and "The Value of Mnemic Psychology for the Interpretation of Dreams and other Phenomena," by Prof. G. S. Brett, the local vice-president of the Section. A new feature is an informal conference of experimentalists on laboratory and applied researches, to be held on Saturday morning, August 9, Dr. C. S. Myers presiding, when several American, Canadian, and British representatives will exchange views.

Individual papers by British psychologists are: "The 'Self' in Cognition—Intuition, Concept, and Sensory Percept," by the Rev. F. Aveling; "Binocular Vision and Correct Ocular Muscle Balance: its Importance in Every-day Life," by Wing-Commander E. C. Clements; (1) "Psychological Theories of Laughter," (2) "Conscious and Unconscious in Psychology," by Dr. J. Drever; "Feeling and Emotion in Daily Life," by Mr. J. C. Flügel; "The Psychology of Déjà Vu," by Dr. J. T. MacCurdy; "Privileges and Limitations of Visual Imagery," by Prof. T. H. Pear; and "Shape-qualities or Relations?" by Prof. C. Spearman.

Section K (Botany).

The programme of the Section is noteworthy for the time which is to be devoted to discussions, either within the Section itself or in conjunction with other Sections. The proceedings start with a discussion on the ascent of sap and transport of food materials in trees, which will be opened by Prof. H. H. Dixon; other speakers will include Dr. O. F. Curtis, of Cornell University, Dr. D. F. MacDougal, Prof. V. H. Blackman, and Prof. J. H. Priestley. Another sectional discussion is to be on Canadian forest problems: the speakers at this meeting include Mr. D. Roy Cameron and Dr. J. M. Swaine, who will deal with forest protection in Canada from fire and insects respectively; Mr. E. H. Finlayson on Canadian silviculture, Dr. A. W. Borthwick on the cultivation outside Canada of Canadian trees, and Messrs. R. D. Craig and F. Storey on world timber supplies.

Joint discussions have been arranged with the Sections of Agriculture and Zoology respectively. At the former, the subject will be "Forest Problems," and four papers on aspects of forestry in the United States and in Canada will be contributed by Mr. J. W. Toumey, Mr. R. D. Craig, Prof. J. H. Faull, of the University of Toronto, and Mr. E. J. Zavitz. This discussion, by representatives from two of the greatest timber-producing countries of the world, should prove of great interest and importance. The

joint meeting with Section D (Zoology) will be to discuss the subject of "Species and Chromosomes." It will be opened by Prof. R. Ruggles Gates, and other speakers are Dr. H. Harrison, Prof. T. H. Morgan, of Columbia University, Mr. Julian Huxley, Miss K. Blackburn, and Mr. A. D. Peacock.

Prof. V. H. Blackman's presidential address to the Section will be entitled "Physiological Aspects of Parasitism." Of the numerous papers to be presented, it is impossible to mention more than a few. Contributions from the North American continent include papers on the "black dot" disease of potato, by Prof. B. T. Dickson; on the fluorescent pigments of the Cyanophyceæ, by Prof. F. E. Lloyd; on the distribution of potassium in plant tissues, by Miss E. S. Dowding; on the status of the biogenic law, by Prof. E. C. Jeffrey; on the growth of British Columbia trees, by Prof. A. H. Hutchinson; and on the behaviour of chloroplasts and other cell contents at low temperature, by Prof. F. J. Lewis. A number of papers will also be presented by British botanists.

SECTION L (EDUCATIONAL SCIENCE).

The Section is to open its session with a paper on the teaching of history and geography of the British Empire by Prof. G. M. Wrong, of the University of Toronto, followed by a paper on modern tendencies in the teaching of geography, by Mr. Ernest Young. The presentation of the Report of the special committee appointed last year to inquire into the educational training of boys and girls in secondary schools for life overseas will be followed by a discussion on the subject to be opened by Sir John Russell.

On the second day Principal Ernest Barker will deliver his presidential address, the subject being the "Nature and Conditions of Academic Freedom in Universities." Mr. A. E. Heath, of the University of Liverpool, will follow with a paper on "Modern Developments in the Method and Scope of Adult Education." A joint discussion with Section J (Psychology) on the subject of "Tests for Scholarships and Promotions" will occupy the third morning; the chief speakers will be Principal Barker, Prof. Cyril Burt, Prof. G. M. Whipple, Prof. B. R. Buckingham, and Prof. Sandiford. The latter in conjunction with Messrs. Brennan and Holmes will also contribute a paper on "The Use of Partial Coefficients of Correlation in Educational Research."

A discussion on "Modern Developments in Science Teaching" is to be opened by Mr. C. M. Stuart, late headmaster of St. Dunstan's School, Catford. Prof. J. L. Myres will read a paper on the place of classics in a secondary school system, to be followed by Mr. A. H. Hope, headmaster of Roan School, Greenwich, on the present position of classics in French secondary schools. The fourth morning will be devoted specially to subjects of Canadian interests. Sir Robert Falconer, president of the University of Toronto, will read a paper on "The Canadian University"; the Hon. Dr. H. J. Cody on the administration of education in Canada; Prof. G. M. Weir on an educational experiment in rural Saskatchewan; Dr. S. B. Sinclair on the selection of pupils for auxiliary classes; and Major J. B. Cowles on the working of the Adolescent Education Act in Ontario.

SECTION M (AGRICULTURE).

The meetings of Section M will be held under the presidency of Sir John Russell, the director of the Rothamsted Experiment Station, whose address on "Combination in tackling Farmers' Problems" will be given on Monday, August 10.

The proceedings on Thursday, August 7, will be opened by a short address by the Hon. J. S. Martin, Minister of Agriculture for the Province of Ontario. He will be followed by Dr. F. T. Shutt on "The Influence of Cropping on the Nitrogen and Organic Matter Content of Western Prairie Soils." Mr. H. J. Page, the head of the Chemical Department at Rothamsted, will read a paper on "Nitrogen Balance in the Soil"; and he will be followed by Dr. Scott Robertson on "The Fertilising Effect of Rock Phosphate." The next morning will be occupied by a joint discussion with Section D (Zoology) on "The Soil Population." This will be opened by Mr. D. Ward Cutler. In the afternoon, Mr. J. B. Reynolds, the principal of the Guelph Agricultural College, will speak on "Agricultural Colleges in Canada."

On Saturday, August 9, Mr. R. A. Fisher, of Rothamsted, will read a paper on "The Incidence of Rainfall in Relation to the Wheat Crop," and later in the morning Dr. McRostie will speak on "Forage Crops in Canada." The same day, Mr. Engledow will read a paper on "A Spacing Experiment with Wheat," which will terminate the day's proceedings.

On Monday, August 11, Mr. Godden will speak on the work which is being carried out at the Rowett Research Institute on the mineral requirements of farm animals, and Prof. Berry will follow with a paper on "The Chemistry of the Oat Crop." The afternoon will be occupied by a joint meeting with Section K (Botany) on "Forest Problems in Canada," to which Mr. Zavitz and Dr. Faull are contributing.

On Tuesday, August 12, the whole morning will be devoted to a joint meeting with Section F (Economics), the subject for discussion being "Diminishing Returns in Agriculture." This discussion will be opened by Dr. C. R. Fay, and it is hoped that other speakers will include Sir John Russell, Lord Bledisloe, Sir Henry Rew, and Mr. Ashby.

The proceedings of the Section will conclude with a joint meeting on forestry with Section K, in which such subjects as forest protection in Canada, and the cultivation of Canadian trees in other parts of the world, will be brought forward.

After the conclusion of the meeting, several local excursions have been arranged, including a visit to the Agricultural College at Guelph.

Atoms and Ethereal Radiations.[1]

IN his first lecture the speaker, after outlining the steps by which he and his collaborators had succeeded in pushing the region of wave-lengths explored by mechanically ruled gratings down to 136 Ångströms, presented the results which had very recently been obtained by Mr. I. S. Bowen and himself, through the analysis, with the use of high resolution, of the fine structure of these extreme ultra-violet lines.

Photographs were shown in which such a close doublet as the B_{III} line at 677 Ångströms was not only clearly resolved, but had its components so well separated that their distance apart, which amounted to but 0·15 Ångströms, could be measured with certainty to 0·01 Ångströms or better, and in which the seven components of the 834·0 line of oxygen were

[1] Abstract, prepared by the author, of three lectures delivered on June 16, 17, and 18, at University College, London, by Robert A. Millikan, Director of the Norman Bridge Laboratory of Physics of the California Institute, Pasadena, entitled (1) "Filling in the Gap between X-rays and Light"; (2) "Electronic Orbits in Atoms"; (3) "The Penetrating Radiations of the Upper Air."

clearly obtained in orders as high as the seventh. This high resolution has made it possible for Mr. Bowen and the author to prove with certainty that in their "hot-sparks" in high vacua, they have succeeded in stripping all of the valence electrons from the series of atoms, lithium, beryllium, boron, carbon, nitrogen and sodium, magnesium, aluminium, silicon, phosphorus, sulphur, six electrons having been removed from the outer shell in the case of the atom of sulphur.

As an illustration of the way in which this can be proved, as well as of the way in which the recently discovered laws of atomic mechanics can be beautifully verified, the lecturer took the case of the stripped boron atom B_{III}, the spectrum of which had not before been known. Mr. Bowen and he first predicted that if they had B_{III} in their source they should have a line at 2077·4 Ångströms. They arrived at this figure by dividing the corresponding line of lithium ($3d$-$4f$) by nine. They then set their spectrograph for this wave-length and obtained the predicted line—quite a strong one—at the accurately measured wave-length of 2077·79 Ångströms. They next predicted a line ($4f$-$5f$) at 4500 Ångströms, and obtained it at 4499 Ångströms, or within one part in 5000 of the predicted wave-length. They next predicted two doublets ($2p$-$3d$) and ($2p$-$3s$), of the same frequency separation at 677 and 758 Ångströms, and found both of them in the positions predicted and with the same frequency separation precisely as their theory demanded, this separation agreeing, too, as it should, with that of the first line of the principal series of B_{III} ($2p$-$2s$) first accurately measured in this work. Photographs showing all these lines as doublets, with the correct separation, were shown.

The speaker concluded his first lecture with the presentation of the proof, furnished by his slides, that the Moseley law of progression of frequencies with atomic number, discovered through the study of X-ray spectra, holds also in the region of optical wave-lengths, such as he has been studying with the aid of his mechanically ruled gratings. In particular he showed that the L_I levels of sodium, magnesium, and aluminium obtained from his "hot sparks" fall, along with that of neon, very accurately upon a Moseley line; also that the strongest L line of the foregoing elements can be plotted upon the same straight line with the corresponding lines obtained by Siegbahn with the elements down to copper; and that a like type of progression was found in the L spectra of the elements from neon down to lithium.

Thus, though the wave-lengths between the lecturer's lower limit of 136 Ångströms reached by grating spectroscopy, and Siegbahn's upper limit of 18 Ångströms, reached by crystal spectroscopy, had not thus far been directly obtained, yet this small remaining gap has been bridged over by the establishment of a common law, with the aid of which it is now possible to compute with certainty some of the most outstanding characteristics of the radiations which must fall in the as yet unexplored region. To this extent then, the gap between X-rays and light has already been completely bridged.

In his second lecture the speaker presented, in a series of tables, work of Mr. Bowen and himself, as yet unpublished, in which two other X-ray laws, namely, the *regular*, or relativity-doublet law, and the *irregular* doublet law were definitely extended throughout the whole field of optics. This extension has become possible because the foregoing series of stripped atoms gives the first opportunity to compare, *in the field of optics*, a fairly long series of atoms possessing exactly the same electronic structure, but in which the nuclear charge progresses by unitary steps. It is in general such a series of identical electronic structures which is dealt with in comparing X-ray spectra. Hence the possibility of a very precise comparison o atomic behaviour in the optical and the X-ray regions

The definite extension by Mr. Bowen and th lecturer of the X-ray laws into the field of optic means unquestionably, to take a simple specific case that in the second quantum state the so-called 2 terms in optics correspond exactly to the L_I term in X-rays, the $2p_2$ terms in optics to the L_{II} term in X-rays, and the $2p_1$ terms in optics to the L_{II} terms in X-rays. Stated otherwise, if the L_{II} and L_{II} levels in X-rays represent a relativity doublet, a they have hitherto been supposed to do, and corre spond therefore to two differently shaped electroni orbits, one a circle $[2_2]$, and one an ellipse $[2_1]$, the p_2 and p_1 in optics also represent a relativity doublet and correspond to these same two orbits.

While from an experimental point of view thi definite unification of optics and X-rays under a common set of laws (Moseley law, relativity-double law, irregular doublet law) must be regarded as a distinct step in advance, since it tends toward a simplification, for the purposes of prediction, of th whole subject, it nevertheless introduces a very seriou difficulty into the present status of atomic theory For it appears to force us to choose between tw positions, either of which presents apparently in superable obstacles.

If we retain the physical interpretation of th relativity-doublet formula—a formula which i derived without the introduction of any arbitrary constant whatever from the theory of the change in mass with speed, and has had *quantitative* successes in interpreting the whole fine structure of the lines of atomic hydrogen and ionised helium—we must discard very largely the interpenetrating-orbit ideas with the aid of which Bohr and other workers have recently interpreted so successfully both optical and chemical phenomena. Specifically the difference between the energies of the so-called s and the p terms in optics can no longer be interpreted as due to the difference in the shapes of the $2s$ and the $2p$ orbits, the $2s$ corresponding to an ellipse, and the $2p_2$ and $2p_1$ to two circles. For if the relativity doublet interpretation is applied to the levels $2p_2$ and $2p_1$, one of these levels, namely $2p_2$, must correspond to an ellipse, while the other, $2p_1$, corresponds to a circle. *This requires that 2s and $2p_2$ be orbits of the same shape, namely, 2_1 orbits, despite their large difference in energy.*

If, on the other hand, we retain the assignment of azimuthal and inner quantum numbers which has been universally made in recent years in the field of optics, and hence make the $2p_2$ and $2p_1$ levels correspond to two circles which differ slightly in energy because of a difference in orientation (inner quantum numbers), we are forced by the results herewith presented to treat L_{II} and L_{III} in the same way. This requires us to find some other cause than change of mass with speed to account for their observed difference in energy, which is, however, quantitatively accounted for by this so-called relativity-doublet theory.

Before the accumulation of the present data it was not so difficult as it is now to discard the relativity-doublet interpretation, but in this data the relativity-doublet formula has had new successes, for it fits satisfactorily with the behaviour of a whole group of atoms which pass over in successive stages toward the structure of atomic hydrogen and ionised helium. Thus there now seems to be no place to stop in discarding the relativity-doublet explanation short of abandoning *in toto* the idea of change of mass with speed in electronic orbits, and assuming that it was mere chance which caused this conception to lead to a formula which has had amazing successes, not

only in predicting exactly the fine structure of the hydrogen and helium lines, but also in explaining very beautifully the complexities of the Stark effect in these gases.

Such an assumption of accidental agreement where the relations are so beautifully quantitative and so numerous as they are here is one which the theoretical physicist will be very loath to make. The lecturer felt that further experimental data must be accumulated before a choice could with certainty be made between his alternatives. The present experimental situation, so far as the work of Mr. Bowen and himself are concerned, will be presented fully in forthcoming articles in the *Physical Review*.

In his lecture on the "Penetrating Radiation of the Upper Air," the results of the experiments made by Mr. Bowen and the lecturer at Kelly Field, Texas, were described. They sent up sounding balloons carrying recording electroscopes, thermometers, and barometers to a height nearly twice as great (about 16 km.) as that reached in preceding studies of the penetrating radiation. The total weight of the whole apparatus sent up, exclusive of the balloons, was but 180 grams. The electroscope chamber consisted of an hermetically sealed, steel-walled vessel of about 200 cc. capacity, containing air at varying pressures ranging from 1 up to 11 atmospheres. Four such instruments had been sent up and three recovered, two of which had reached altitudes between 15 and 16 km., and both agreed in giving the integrated ionisation not more than 25 per cent. of that obtained by extrapolation from Kolhörster's curves or computed from his 1914 absorption coefficient $\mu/D = 5{\cdot}77 \times 10^{-3}$ cm.^{2}/gm. These results showed quite definitely that no external source of radiation having the postulated characteristics existed. At the same time, they showed that the balloons in their ascent passed through regions in which the penetrating radiation was greater than its value at the earth's surface, since the integrated leak could not otherwise be greater than its value at the surface.

Dr. Russel Otis, of the California Institute at Pasadena, then checked these results by observations made in a number of aeroplane flights up to altitudes of 17,000 ft. In these flights he calibrated his electroscope at each particular level, thus rendering his results quite independent of any possible effects of temperature and pressure. He found, in agreement with Kolhörster, Hess, and others, that the penetrating radiation decreases slightly up to altitudes of six or eight thousand feet and then begins to increase. The actual values at 17,000 ft. (5·18 km.) were, however, but half those reported by Kolhörster at this altitude. Observations which Dr. Otis then made on Mt. Whitney at altitudes up to 13,000 ft. checked quite well with those made in aeroplanes, thus indicating that the phenomenon is one due to altitude rather than to locality.

The most conclusive evidence as to the source of the radiation has come from a continuous series of night and day observations, inside and outside 5 cm. thick lead screens, which the lecturer and Dr. Otis carried out last September on the top of Pikes Peak (14,100 ft.) in Colorado. During these observations, as a result of a snowstorm, the ionisation inside the closed observing chamber dropped suddenly about 10 per cent., but when the test was made inside the chamber *when it was completely shielded by its 5 cm. of lead*, the percentage fall in the ionisation was about the same as in the unshielded chamber, thus indicating that *local causes* modified the ionisation which got through 5 cm. of lead as much as they modified that which did not have to go through such a screen. If a very penetrating radiation of cosmical origin existed, this should have been completely unmodified by local changes, so that the percentage change inside the shielded vessel should have been very much less than that observed when the shields were removed. This observation was, then, an indication that the whole of the radiation measured in the closed vessel was of local origin.

This indication was confirmed as follows: assuming, following Kolhörster's 1923 conclusions, a penetrating radiation of cosmic origin which produces 2 ions/cc./sec. at sea-level, and has an absorption coefficient per cm. in water of $\alpha = 2{\cdot}5 \times 10^{-3}$, we find that this radiation would produce 6 ions/cc./sec. on top of Pikes Peak and 5·2 inside our lead shield. We found that the ionisation in our chamber contributed by the walls and the lead shields was at least 7 ions, so that if there were no local radiation at all on Pikes Peak capable of getting through our screens, a condition contrary to fact, the lowest obtainable value of the ionisation inside our vessel should have been $7 + 5{\cdot}2 = 12{\cdot}2$ ions. *We observed directly 11 ions.* We conclude, therefore, that there can exist no such penetrating radiation as we have assumed.

Our observations, therefore, seem to us to show that the whole of the penetrating radiation on top of Pikes Peak is of local origin. We have computed its absorption coefficient and find it but a little harder than that of the ordinary radioactive materials. How such quantities of radioactive material get into the upper atmosphere is as yet unknown.

University and Educational Intelligence.

BELFAST.—At the meeting of Senate of the Queen's University held on July 16, a letter was read from the trustees of the late J. C. White intimating that they intended to hand over to the University a sum of 60,000*l*. Of this amount (1) a sum of 45,000*l*. is to be used in founding a professorship of biochemistry with a salary of 800*l*. per annum and equipping the department. (2) The remaining 15,000*l*. is to be used in founding a lectureship in bacteriology with a salary of 450*l*. and equipping the department. The title of the professorship is to be the "J. C. White Professorship of Bio-chemistry," and the title of the lectureship the "J. C. White Lectureship in Bacteriology."

On July 17 the cheque for 60,000*l*. was handed to the honorary treasurer of the University.

CAMBRIDGE.—The Local Lectures summer meeting will be held on August 1-21, and an attractive programme has been issued. The chief subject of study will be Egypt, its ancient, medieval, and modern aspects, and among the lecturers who have been secured are Sir Flinders Petrie, Prof. A. S. Hunt, Dr. A. H. Gardiner, Dr. A. M. Blackman, Dr. W. F. Hume, and Sir William Willcocks. The group of lecturers on science include many of the leading scientific workers in the University, with the addition of Dr. Leonard Hill, director of the Department of Applied Physiology, Medical Research Committee, Prof. H. H. Turner of Oxford, and Dr. A. E. H. Tutton. The inaugural address to the meeting will be delivered by Viscount Haldane. Further information can be obtained by application to Dr. Cranage, Syndicate Buildings, Cambridge; letters should be endorsed "Summer Meeting."

EDINBURGH.—The following doctorates were conferred at the Graduation Ceremony on July 17, the subject of the thesis in each case following the name:—*D.Sc.*: Mr. T. M. Finlay, "The Old Red Sandstone of Shetland"; Dr. R. K. S. Lim, "Gastric

Secretion"; Mr. G. P. Douglas, "The Effect of High Tip Speeds on the Performance of Aeroplane Propellers"; D. Penman, (*a*) "Investigations relating to Temperature Conditions in Indian Mines and to the Explosibility of Indian Coal Dusts"; (*b*) Development of a Simplified View of Mine Ventilating Resistances, with Supplementary Papers." *Ph.D.*: Mr. R. T. Dunbar, "Experiments on the Absorption of X-radiation of Short Wave-length, and on the Associated Scattered and Corpuscular Radiation"; Mr. D. A. W. Fairweather, "The Electrolysis of Salts of Alkyloxyacids"; Honor Bridget Fell, "Histological Studies on the Gonads of the Fowl"; Mr. R. E. Gibson, "The Electrolysis of a Mixture of the Potassium Salts of Acetic and Trichloracetic Acids and on the Nature of Kolbe's Electrosynthesis and Allied Reactions"; Mr. J. Haldane, "The Action of Diphenylformamidine on the Phenols"; Mr. J. H. Kenneth, "An Experimental Study of Effects and Associations due to Certain Odours"; Satis Ranjan Khastgir, "The Scattering of X-Rays and the J-Absorption Phenomenon"; Christina Cruickshank Miller, "Diffusion in Solution"; Mr. T. R. Paterson, "The Influence of Substitution on the Velocity of Reaction between Benzoic Anhydride and an Aliphatic Alcohol"; Mr. W. Robson, (*a*) "The Metabolism of Tryptophane—the Synthesis of Bz-3-Methyltryptophane; (*b*) "The Influence of Insulin on Acidosis and Lipæmia in Diabetes"; Mr. R. H. Slater, "The Influence of the Nature and Position of Atoms in Organic Compounds on the Reactivity of other Atoms in the Molecule. Polarity Effects in Aromatic Halogen Compounds"; Mr. C. M. Yonge, "The Mechanism of Feeding, Digestion, and Assimilation in *Nephrops norvegicus*."

A Diploma in Technical Chemistry is now granted by the University to graduates of British or other approved universities who have taken a degree in science with honours in chemistry. The course of study for the Diploma extends over one academic year, and comprises instruction not only in technical chemistry but also in the elements of engineering practice, and in factory organisation and factory accounting.

Dr. D. Murray Lyon has been appointed Christison professor of therapeutics, in succession to Prof. J. C. Meakins.

Lieut.-Col. E. D. W. Greig has been appointed lecturer in tropical diseases. Lieut.-Col. Greig was formerly Director of Medical Research in India.

Among the recipients of the honorary degree of Doctor of Laws on July 17 were the following: Mrs. Sidney Webb; Mr. F. R. Jamieson, Senior Inspector of Schools; Sir David O. Masson, professor of chemistry at Melbourne; Prof. C. J. Martin, Director of the Lister Institute of Preventive Medicine; Prof. S. J. Hickson, of Manchester; Mr. G. G. Chisholm, formerly reader in geography at the University.

Dr. D. P. D. Wilkie, lecturer in clinical surgery, has been appointed to the chair of surgery for a period of ten years.

GLASGOW.—Mr. Hector J. W. Hetherington, principal of the University College of the South-West of England, Exeter, has been appointed to the chair of moral philosophy, in succession to Prof. Lindsay, now the Master of Balliol.

LEEDS.—Prof. J. B. Baillie, professor of moral philosophy in the University of Aberdeen, has been appointed Vice-Chancellor of the University, in succession to Sir Michael Sadler. Prof. Baillie was educated at Edinburgh, Trinity College, Cambridge, Halle, Strasbourg, and Paris.

MANCHESTER.—Mr. E. A. Milne, assistant director of the Solar Physics Observatory at Cambridge, has been appointed to the Beyer chair of applied mathematics.

ST. ANDREWS.—A letter was read from Prof. A. E. Taylor resigning the chair of moral philosophy in the University on his appointment to the chair of moral philosophy in the University of Edinburgh. The Court resolved to tender their congratulations to Prof. Taylor on his appointment, and to express their appreciation of the good fortune which has enabled this University to enjoy the benefits of his scholarship and share in his reputation for a fruitful period of sixteen years.

It was unanimously agreed to invite Mr. David Morrison, lecturer in logic in the United College, St. Andrews, and in University College, Dundee, to accept the vacant professorship as from October 1 next.

The Court resolved to appoint Dr. G. McOwan, assistant to the professor of chemistry, St. Andrews, to be lecturer in organic chemistry in the United College in succession to Dr. A. K. Macbeth, resigned. It was intimated that Mr. J. Stirling had resigned the post of assistant to the lecturer in botany in the United College, St. Andrews, on his appointment to a junior lectureship in the University of Liverpool. The Court approved the appointment of Mr. J. Duke Stewart as a tutor in anæsthetics in the University.

THE vacant principalship of the Northampton Polytechnic Institute, Clerkenwell, caused by the tragic death of Dr. R. Mullineux Walmsley in June, has been filled by the appointment of Mr. S. C. Laws, principal of the Wigan Mining and Technical College for the past nine years. The appointment is subject to the approval of the London County Council. Mr. Laws was educated at University College, Nottingham, and St. John's College, Cambridge, where he attended as an 1851 Exhibition research scholar and was admitted as an advanced student. He worked at Cambridge at the Cavendish Laboratory under Sir J. J. Thomson and received the special distinction of an extension of his scholarship for a third year, the University of Cambridge awarding him the certificate for distinguished research.

THE Universities' Library for Central Europe, established four years ago under the presidency of the late Viscount Bryce to meet the book-famine in the universities of central European countries, is appealing for funds to enable it to continue its work for at least another twelve months, after which it is anticipated that the economic conditions of those countries will have improved so as to render such external help less needful. The report of the executive committee for the two years 1922–24 shows that during that time 14,000 volumes and 25,000 periodicals were received by gift, and more than 1500 volumes by purchase. The presentations included several sets of NATURE and other journals. The number of consignments despatched were: To Austria 22, Czecho-Slovakia 37, Danzig 4, Finland 10, Germany 64, Hungary 10, Poland 19, Roumania 3, Russia 34. Among the subsidiary activities of the organisation may be mentioned: co-operation with the Vienna International Summer School and with the British Committee for aiding men of letters and science in Russia, and despatching French books to Paris for villages in the devastated areas. The honorary secretary is Mr. B. M. Headicar, of the London School of Economics. Contributions, which may be earmarked for any particular country or university, should be sent to Sir George S. Gibb, London School of Economics, Houghton Street, London, W.C.2.

Early Science at the Royal Society.

July 27, 1664. Ordered, That at the first opportunity Mr. Hooke be put to the scrutiny for the place of curator: That he forthwith provide himself of a lodging in or near Gresham College: And that these orders and votes be kept secret, till Sir John Cutler shall have established Mr. Hooke as professor of the histories of trades.

1681. The President [Wren], Mr. Henshaw, Mr. Colwall, Dr. Gale, Dr. Croune, Dr. King and Mr. Hooke were appointed a committee to go to Chelsea, and to meet at the Swan-tavern there at nine in the morning to speak with the Lord Cheney about inclosing the ground of Chelsea-college next the meadows.

July 28, 1670. The society thinking proper to discontinue their public weekly meetings, there was recommended to Mr. Hooke during this recess the care of these three things: 1. To continue to observe, whether there be a parallax in the earth's orb. 2. To observe the present variation of the needle. 3. To measure the quantity of a degree upon the earth.

1686. There happened much discourse about the way of preserving ships from the worms; and it was remarked, that sheathing with lead was the best expedient, and found to be so by the experience of Sir Anthony Deane; but that the carpenters opposed it as against their profit, affirming that the iron of the rudders so sheathed was more apt to be corroded.

July 30, 1663. Christopher Wren to the president [Viscount Brouncker]—"The act and noise of Oxford being over, I retired to myself as speedily as I could, to obey your lordship, and contribute something to the collection of experiments designed by the society for his majesty's reception. The solemnity of the occasion, and my solicitude for the honour of the society, make me think nothing proper, nothing remarkable enough. It is not every year will produce such a master experiment as the Torricellian, and so fruitful as that is, of new experiments; and therefore the society hath deservedly spent much time upon that and its offspring. To produce knacks only, and things to raise wonder, such as Kircher, Schottus, and even jugglers abound with, scarce become the gravity of the occasion. It must therefore be something between both, luciferous in philosophy, and yet whose use and advantage is obvious without a lecture. . . . It is upon billiards and tennis-balls, upon the purling of sticks and tops, upon a vial of water, or a wedge of glass, that the great Des Cartes hath built the most refined accurate theories that human wit ever reached to. For myself, I must profess freely I have not anything by me suitable to the idea I have of what ought to be performed upon this occasion. . . .

1668. The experiment of shutting up two finches in two glasses of different capacity was tried. The vessels were closed with very good cement, the one containing about four and a half times the liquor of the other. The birds were both put in at the time of fifty-five minutes past four. That in the smaller glass appearing ready to die, after nineteen minutes, was taken out, but found dead. The other was kept in about an hour and twenty-eight minutes, and appearing to be sick, though not so very much so, was taken out, it being time for the society to rise; whereby it seemed, that the times and the quantities of the air necessary for respiration in these birds were almost in reciprocal proportion to one another.

August 1, 1678. Some mention was made of cures done by the natural heat of living bodies outwardly applied. Sir Christopher Wren observed, that the raising of a blister would cure the stinging of wasps. . . .

Societies and Academies.

LONDON.

Geological Society, June 25.—Dr. J. W. Evans, president, in the chair.—Miss M. E. **Tomlinson**: The river-deposits of the lower valley of the Warwickshire Avon; with an appendix by A. S. **Kennard** and B. B. **Woodward.** Fluviatile sands and gravels occur as river-terraces between Stratford and Tewkesbury. The surfaces of these terraces lie on curves parallel to the present thalweg of the Avon. Five such terraces have been identified. No. 5 Terrace, the highest above river-level, has yielded no contemporaneous fossils. No. 4 and No. 3 both contain a warm fauna, with Hippopotamus and *Belgrandia marginata* occurring solely at No. 3 level, and *Corbicula fluminalis* at No. 4 level. No. 2 contains a cold fauna, with numerous remains of mammoth and *Rhinoceros tichorhinus*. No. 1 probably underlies the alluvium, and may be connected with the infilling of the buried channel which has been identified at Fladbury and Tewkesbury. The sole evidence of human industry found is a fresh flint of Mousterian type from No. 2 Terrace.—F. **Raw**: The development of *Leptoplastus salteri* Callaway, and of other trilobites (Olenidæ, Ptychoparidæ, Conocoryphidæ, Paradoxidæ, Phacopidæ, and Mesonacidæ). *Leptoplastus salteri* occurs in the Upper Tremadoc horizon of Shineton Brook (Salop). All stages of development are noted, except the protaspis. The development is divided into successive stages. The earliest stage has a long, simply segmented glabella; long pleural spines occur throughout the body, including three pairs on the head and four on the pygidium; while axial spines occur from the occipital segment throughout. In the last stage the glabella is short, conical, and smooth; of pleural spines, only the genal remain on the head, those in the thorax are reduced, and none remain on the pygidium, where axial spines are also wanting. With certain reservations, these four stages are also claimed to represent successive stages in the phylogeny. This ontogeny sheds much light on that of other trilobites. In the ontogenies of several families, it is the primitively posterior head-spines that at first are dominant—to be superseded later by the middle pair. In Mesonacidæ these again are succeeded by the anterior pair, which, in their lateral revolution, carried before them the anterior branches of the facial sutures, so that these cut the posterior border; they also stretched out the antero-marginal suture to the genal angle. These changes led to the supersession of the dorsal facial suture by the marginal suture, with consequent ankylosis along the former. The family is hereby claimed to have a head-structure not hitherto recognised. It illustrates a general principle—that those only of the cephalic sutures are retained as were necessary for ecdysis. The combined study of trilobite ontogeny and morphology strongly suggests, as Beecher claimed, that here the ontogeny extensively recapitulates the phylogeny; and therefore best indicates relationships. This indicates an early divergence in glabella-form, antedating divergences in cephalic spines and sutures. Members of a "natural" order may, therefore, be expected to agree much more in glabella-form than in the cephalic suture, which has latterly been made the basis of classification.

Physical Society, June 27.—Mr. F. E. Smith in the chair.—O. W. **Richardson**: Thermionic emission from systems with multiple thresholds. The question of the connexion between thermionic emission and the internal electron levels of the emitting substance must be faced. The theoretical problem is attacked from

three different points of view, namely, (*a*) classical statistical mechanics, (*b*) chemical dynamics, and (*c*) the laws of photo-electric action. As a result it seems possible to exclude certain alternatives which might otherwise have appeared not improbable and to formulate a set of rules governing the fundamental phenomena which are not in conflict either with the known facts or with any well-recognised relevant principle.—F. C. **Toy**: A selenium photometer. The instrument was designed for use by photographic manufacturers in measuring the density of a negative after test exposures which vary from strip to strip of the negative. By means of a selenium cell, the intensities of two beams of light are compared, one of which passes through the part of the negative to be tested while the other passes through a compensating wedge which has to be adjusted until its effect on the second beam is equal to that of the negative on the first beam. As one beam is progressively obscured by one shutter, the other is progressively opened, the total illumination of the selenium cell remaining constant provided that the two beams on reaching it are of equal intensity. The method is extremely accurate.—L. **Hartshorn**: A method of measuring very small capacities. A bridge arrangement is described suitable for the measurement of very small capacities (of the order of 1 micro-microfarad and less) at telephonic frequencies. Means of securing (1) great sensitivity, (2) fineness of adjustment, and (3) elimination of capacities to earth and capacities due to the presence of connecting leads, are indicated, so that it is possible to measure the true inter-capacity between any two conductors, *e.g.* the electrodes of a thermionic valve. As a test of the method, it is used to measure the capacity between two steel balls of 1 cm. radius and at distances apart of 2·25 to 8 cm.—E. **Wilson**: A new form of string galvanometer. The magnets consist of two rings of cobalt chrome steel of 25 cm. diameter, the cross-section of the bar being 5 cm. × 1 cm. Each ring has an air gap of 0·1 cm., and the poles have a bevel of 45°, terminating in opposing faces of 0·4 cm. wide. The magnets are mounted one above the other, with their gaps in line, and a separation between the rings of 1 cm. The strings, two in number, are of platinum wire 0·002 cm. diameter, and are supported symmetrically in the gap by a brass former, the effective length of each string being 10 cm. —W. E. **Curtis**: The phosphorescence of fused transparent silica. A mercury lamp and a hydrogen tube, both of transparent silica, were used. Heat increases the intensity of the phosphorescence and decreases its duration. With helium containing a trace of hydrogen, it was found that whereas a condensed (oscillatory) discharge gave the Balmer lines faintly and feeble phosphorescence, an uncondensed (unidirectional) discharge developed neither Balmer lines nor phosphorescence. There was also a correspondence between the localisation of the Balmer lines and that of the phosphorescence. On admitting hydrogen to the helium tube by making it red hot, the phosphorescence was obtained strongly. The effect may be due to radiation of wave-lengths occurring in the hydrogen spectrum, but absent from the helium spectrum; the Lyman series of hydrogen, which lies between λλ 1,215-912 A, is probably the effective radiation.

Aristotelian Society, July 7.—Prof. T. P. Nunn, president, in the chair.—H. Wildon **Carr**: The scientific approach to philosophy. There are two problems of philosophy which are fundamental in their relation to present scientific research. The first concerns the biological sciences. It is the problem of the nature and genesis of the human intellect, whether it is essentially a cognitive faculty of receiving a revelation of reality by simple contemplation and natural reasoning, or whether it is a mode of cognitive activity produced in the evolution of life for a vital purpose, that is, to serve a special form of living activity. The second problem concerns the subject-matter of mathematics and physics. It is the problem of the subjective conditions of sense experience imposed on the observer of Nature, how far they must be held to qualify the objectivity of the results of observation and in what way they can be allowed for or abstracted from. Neither of these problems can be ignored by the scientific researcher, and both carry science beyond the realms of physics and biology into metaphysics and philosophy. The first is the leading motive in the philosophy of Bergson. The second is being forced on the attention of philosophers by the new principle of relativity of Einstein.

DUBLIN.

Royal Irish Academy, June 23.—Prof. Sydney Young, president, in the chair.—K. C. **Bailey** and Mrs. D. F. H. **Bailey**: The colorimetric estimation of thiocyanates and cyanates. The tests proposed by Spacu and by E. A. Werner for the detection of thiocyanates and cyanates respectively by the formation of coloured compounds with copper and pyridine are adapted to the colorimetric estimation of these substances. The estimation can be successfully performed in the presence of most common acids, bases and salts. Cyanates can be estimated thus in the presence of urea, but thiourea interferes with the estimation of thiocyanates.—J. J. **Dowling** and J. A. C. **Teegan**: Optical interference experiments with multiple sources. By the use of a train of two or more biprisms, multiple images of an illuminated slit are obtained. The resultant interference pattern has been observed corresponding to light sources arranged in any symmetrical formation. The fact that these sources do not lie in one plane introduces difficulties.

Royal Dublin Society, June 24.—Prof. J. A. Scott in the chair.—H. H. **Dixon**: Variations in the permeability of leaf-cells. With suitable arrangements, large changes in the electrical resistance of leaf-tissues may be shown to be associated with changes of temperature. Thus it may be inferred that the permeability of the component cells is doubled for a temperature rise of 10° to 30° C. Observations with specially constructed thermocouples show that leaves exposed to sunshine are often many degrees warmer than adjacent shaded leaves, and air-currents often lead to fluctuations of several degrees within a minute. Such temperature differences must give rise to alterations in the permeability of the cells. These permeability variations coupled with tensile stresses in the sap will lead to the transport of materials from the more permeable cells.

EDINBURGH.

Royal Society, July 7.—J. H. Ashworth, vice-president, in the chair.—D. H. **Scott**: Fossil plants of the Calamopitys type, from the Carboniferous rocks of Scotland. The stems of four plants are discussed. They are referred, provisionally, to the family Calamopiteæ, a group, placed among the Pteridosperms or "Seed-ferns" on the ground of anatomical characters. *Calamopitys radiata*, from the Cementstone group of Dumbartonshire, has pith that contains elements resembling tracheids, and may therefore have been a "mixed pith." The strands of primary wood surrounding the pith are large. The secondary wood is remarkable for the enormous width of many of the medullary rays, so that the woody zone consists largely of cellular tissue. This feature distinguishes the plant from all the other known species of the

oup. *Endoxylon zonatum* was found in the Carbon-rous Limestone series, Dalry, Ayrshire, by the late r. John Young of Glasgow. The large pith consists nolly of cellular tissue, surrounded by a number of attered strands of primary wood. The secondary ood has very narrow, and usually low medullary ys, and is notable for showing well-marked annual gs, characterised by the narrow-celled zones of autumn-wood." The bark is preserved in this ecimen, an unusual feature. The other specimens ustrate two species of the genus, Bilignea, a genus unded by Dr. Kidston, and characterised by the ct that the pith is wholly replaced by a massive ntral column of short tracheids, presumably for the orage of water. This genus may be described as istophyton with the pith replaced by a column of ater-storing tracheids. Whether this peculiar struc-re was derived from a primitively solid wood or m a pre-existing pith cannot yet be decided.—L. **Ince**: On a class of partial differential equations. quations of which $\frac{\partial^2 z}{\partial x^2}+\frac{\partial^2 z}{\partial y^2}+(n+1-x^2-y^2)z=0$ is pical are considered; a set of particular solutions d a solution of a general character are obtained.—r Thomas **Muir**: The theory of circulants from 1900 1920.

PARIS.

Academy of Sciences, June 23.—M. Guillaume gourdan in the chair.—G. **Bigourdan**: The deter-ination of time, and the modified use of the ethod of corresponding heights. A review of the s methods that have been used, with discussion the relative advantages and disadvantages of ch. The method of corresponding heights of own stars has for a long time been considered the st exact: a modification leading to increased pre-ion is proposed.—F. **Widal**, P. **Abrami**, A. **Weill**, d **Laudat**: Hydremia in the course of diabetes der insulin treatment. Variations in the refractive dex of the serum. Insulin profoundly affects ter metabolism, causing blood dilution, and these anges can be conveniently followed by the refracto-eter.—Pierre **Weiss** and Mlle. Paule **Collet**: Para-gnetism independent of the temperature.—V. **Grignard** and R. **Stratford**: The catalytic decomposi-on of hexahydroaromatic and saturated fatty drocarbons. Contribution to the study of the cking of petrol. The decomposition of pure indivi-ual hydrocarbons has been studied; anhydrous aminium chloride was used as catalyst and the tem-ratures were generally between 120° and 150° C. he gaseous and liquid products of the reaction were entified. The substituted cyclohexanes undergo a uble transformation, a cracking increasing with the gth of the side chain, and isomerisation leading to lymethyl cyclohexanes. Both fatty hydrocarbons d substituted cyclohexanes give normal butane der the action of aluminium chloride.—Jean **Effront**: The toxicity of copper salts.—M. Giovanni attista De Tori was elected correspondant for the ction of botany in succession to the late M. Warming.—Marcel **Légaut**: The systems of points in a plane.—**Maneff**: Gravitation and the principle of action d reaction.—M. de **Fleury**: Concerning the use of ht or extra-light alloys for the pistons of internal mbustion engines.—P. **Dumanois**: Concerning iation motors with very high compression. Some nsequences resulting from the use of an antiknock-g compound, such as lead tetra-ethyl, in petrol used f aviation motors.—V. **Michkovitch** and E. **Mallein**: prism astrolable with an impersonal micrometer.—fred **Lartigue**: The application to thermodynamics the representation of Fresnel.—P. **Lejay**: The use of lamps with several electrodes in electrometry.—Georges **Chaudron** and Hubert **Forestier**: Study of the decomposition of ferrous oxide. Anomalies of expansion corresponding with its instability. It has been shown in an earlier communication that ferrous oxide is unstable below 570° C. and that it decomposes according to the reaction $4FeO \rightleftharpoons Fe_3O_4 + Fe$. The present paper gives the result of a study of the velocities of these two inverse reactions.—P. **Laffitte**: The spectroscopy of explosions. With a gaseous explosive the spectrum of the explosive wave, and that of the period of combustion, is a continuous spectrum, the only lines observed being those of elements in the walls of the containing tube. For a solid explosive, the spectrum is continuous without lines.—A. **Damiens**: The absorption of carbon monoxide by cuprous sulphate in the presence of sulphuric acid. Application to the production of hydrogen from water gas. With cuprous oxide dissolved in strong sulphuric acid, the absorption of carbon monoxide is complete up to the limit one molecule of carbon monoxide to one molecule of copper sulphate, and no gas is evolved by this solution in a vacuum. The carbon monoxide is removed by dilution and warming.—Edmond **Bayle** and René **Fabre**: Study of the fluorescence of the alkaloids of the isoquinoline and tetrahydroisoquinoline groups, papaverine, narcotine, hydrastine, and their products of oxidation.—E. **Darmois** and A. **Honnelaitre**: The electrometric study of the acidity of mixtures of malic acid and molybdic acid. The results of the measurements confirm those obtained by the polarimeter: the latter method, however, is much more sensitive.—P. **Lasareff**: A possible cause of the anomaly of gravity at Koursk (Central Russia).—E. **Chaput**: Two types of alluvial sheets: monogenic and polygenic terraces.—Emile **Saillard**: Estimation of raffinose in sugars. Proportion of raffinose in molasses.—R. **Courrier**: New researches on folliculine. Contribution to the study of the passage of hormones through the placenta.—D. **Bach**: Variations of the concentration of hydrogen ions in the course of the assimilation of the ammonium salts of strong acids by *Aspergillus repens*.—A. **Fernbach** and N. **Schiller**: The rôle of the reaction of the medium in elective fermentation.—G. **Petit**: The morphogemy of the kidney of the sirenians.—Ph. **Joyet-Lavergne**: The evolution of the cytoplasmic elements in the cycle of *Aggregata Eberthi*.—A. **Donatien** and F. **Lestoquard**: Pernicious anæmia of the sheep and the goat.—B. **Issatchenko**: Sulphuretted hydrogen fermentation in the Black Sea. The reduction of sulphates to sulphuretted hydrogen in the Black Sea appears to be due to an organism identical with one described by Beijerinck and by van Delden under the name of *Microspira æstuarii*.—MM. **Ménard** and **Foubert**: The technique of the treatment of medico-surgical affections by ultraviolet light.—H. **Penau** and H. **Simonnet**: Experimental pancreatic diabetes and insulin.

COPENHAGEN.

Royal Danish Academy of Sciences, February 1.—N. E. **Nørlund**: On the series of interpolation. A determination of the class of functions which may be represented by the usual expansions of the interpolation theory.

February 15.—J. L. W. V. **Jensen**: Results of some earlier mathematical investigations, hitherto unpublished: (1) Asymptotic determination of the roots of the Q-function of Prym.

March 14.—N. **Bjerrum**: On the dissociation constant of methyl alcohol, worked out together with Miss Unmack and L. Zechmeister. Methyl alcohol dissociates reversibly into ions, and the dissociation

constant is determined at different temperatures and ion-concentrations.

March 28.—Harald **Bohr**: Quasi-periodic functions. General determination of the classes of functions which can be resolved into arbitrarily chosen vibrations (harmonic or otherwise). The inquiry forms a generalisation of the theory of the usual Fourier series. With the help of certain generalisations of the notion of periodicity, it is possible to reach a simple and complete characterisation of the class of functions indicated.

April 11.—P. O. **Pedersen**: On electric sparks. (2) An experimental investigation on time-lag in the electric spark and on spark-formation under various conditions. (3) It is shown that the present theory of the electric spark in some essential points is contradictory to experience and particularly to the experimental results described in (1) and (2). The outline of a new spark theory is sketched.

April 25.—L. Kolderup **Rosenvinge**: The marine Algæ of Denmark, (3): Ceramiales. The Danish species of this order, contributions to their morphology and development, their fructification and occurrence in Danish waters.—Niels **Nielson**: An equation of Lagrange studied by Cayley. The memoir gives a generalisation of the equation studied by Cayley (*Journal de Crelle*, vol. 53). The parameter 4 is replaced by any power of any prime number whatever. The memoir gives the necessary and sufficient conditions for the solution of this generalised equation, also formulæ which allow certain equations corresponding to parameter 4 to be solved at once or proved insoluble.

ROME.

Royal Academy of the Lincei, May 4.—C. **Segre**: Curvilinear elements having tangent and osculatory plane in common.—A. **Angeli**: Analogies in behaviour between certain derivatives of benzene and the corresponding derivatives of the aliphatic series.—G. **Armellini**: Observations on the diameter of the sun made at the Royal Rome Observatory on the Campidoglio. The meridian observations taken at this observatory during the past forty years are used as the basis of calculations of the sun's diameter. The results are independent of any personal factor and are subject only to a very small error due to the inclination to the vertical of the micrometer wires of the transit instrument. The mean value of the radius of the sun at the mean distance, increased by radiation, is found to be $R = 16'1{\cdot}40'' \pm 0{\cdot}02''$, which is almost coincident with that usually accepted, namely, 16′1·18″.—G. **Gherardelli**: Oblique algebraic curves with only autodual branches.—A. **Myller**: Concurrent directions on a surface emerging from the points of a curve.—M. **Picone**: Necessary and sufficient conditions for the existence and calculation of a periodic solution for the most general system of ordinary differential equations.—G. **Charrier**: Oxidation of 2-*N*-phenyl-$\alpha\beta$-naphthatriazole by means of alkaline potassium permanganate solution.—G. R. **Levi** and G. **Natta**: Action of aluminium sulphide on certain organic compounds. At high temperatures, the action of aluminium sulphide on benzene results in the formation of various condensed aromatic hydrocarbons. Under similar conditions, phenols or naphthols are transformed into the corresponding oxides, whereas from alcohols of the aliphatic series, mercaptans may be obtained in good yield and free from organic sulphides.—B. **Oddo** and D. **Curti**: Oximic and iminic compound of the phthalein of phenol.—A. **Desio**: Geological constitution of certain islands in the Ægean Sea.—A. **Clementi**: Osmotic pressure in terrestrial invertebrates. Just as is the case with the vertebrates, so also with the invertebrates, the osmotic pressure of the internal fluids of the organism is less with terrestrial than with marine species, the maximum value in the case of one and the s organism being less in the internal fluids than in solid tissues.—M. **Sella**: Observations on the deve ment and anatomy of the myotome in the Teleos

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NATURE

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2857, VOL. 114]

Museums and the British Empire.

IT was fitting that the Museums Association should hold its annual conference this year at Wembley, for the Exhibition is a great museum of Empire, a marvellous example of that education by the visual appeal of concrete objects which is the special characteristic of museum teaching. The inspiration it might afford to the large gathering of museum officials from these islands and from the Dominions overseas was well brought out in the presidential address of Dr. Herbert Bolton, of the Bristol Museum. Trained at the Manchester Museum, for many years director of one of our oldest and best provincial museums, personally acquainted with museum work in the Dominions and the United States, and one who has achieved scientific and academic distinction in the course of his professional labours, Dr. Bolton is eminently fitted to take advantage of the situation, and his constructive criticisms are worthy of respectful scrutiny.

That the museum method is of practical use to practical men is shown clearly enough by the British Empire Exhibition, and so successfully that the Prince of Wales has recently advocated the maintenance of the Exhibition throughout another year. What is still more important is that the impulse given should be guided into those permanent institutions which are intended for the same purpose. It would, indeed, be absurd to organise a vast temporary show of the Empire and to close down the galleries and collections of the Imperial Institute ; fortunately we are, as it seems, to be spared that threatened disgrace. But, as Dr. Bolton urged, the Imperial Institute should not stand alone ; existing museums all over the country should carry on the work, leading, it may be, to the establishment of independent commercial museums in the large industrial centres. Australia, ever advancing, has shown the way in the Technological Museum of Sydney ; Japan, seizing on that which is good in Western civilisation, has trade museums, not only at Osaka, but also scattered throughout the country. The most remarkable example doubtless is the Commercial Museum of Philadelphia, "which has done more to stimulate the trade and commerce of that city than all the other agencies put together." Not that Britain is so far behind : the museums of Sheffield, Halifax, and Hull, for example, have formed collections of metal-work, textiles, and shipping respectively, while for an example of the special museum of industry we need only recall that of the Potteries at Hanley.

Let us not, however, restrict our view to commerce. Public health, to take an activity so admirably illustrated by the tropical diseases exhibit in the Government Building at Wembley, is a subject that can and should be advanced by our ordinary museums. We

cannot have forgotten how several of them rose to the occasion presented by the War, and Dr. Bolton reminded us of the valuable work then done at the Natural History Museum by research and exposition. But all this can be, and indeed is, pursued with profit in times of peace. The American Museum of Natural History in New York has even founded a separate health department.

Space forbids us to follow Dr. Bolton through the many fields in which museums can be of service to the community, from the highest ideals of art to the manurial depths of agriculture, but we must applaud the emphasis with which he once more urges that the prosecution of research is no less incumbent on museums than is the exposition of its results. Here, however, if not before, we are brought up against a formidable obstacle. While our museum officials either have, like Dr. Bolton, been raising themselves to the level of university investigators, or have been increasingly drawn from the higher classes of university graduates, while they have, in short, become skilled men of science no less than highly trained curators, their numbers have not kept pace with the growth of their collections or with the increased demands made on them by the public. Dr. Bolton takes as his example the British Museum (Natural History). As an interested onlooker he asserts that :

"The tasks with which each man has to deal are herculean, and can never be mastered by any one man. Every scientific man of note in the whole world interested in the sciences represented there visits it for study and inquiry, whilst general inquiries are legion. Collections pour in; the labours of Sisyphus were mild in comparison with those of the staff of this museum, for his labours never increased, whilst theirs are continuously mounting up. But this does not touch the question of research. These men do carry out research, but only by making the hours of life the hours of labour. I do not hesitate to say that in the interests of the nation and of the Empire the national museums call for a drastic reorganisation, in order that their hidden treasures may become available for an Empire's betterment and a people's welfare."

It is, indeed, deplorable that this can be said, and said with truth, of the central museum of the Empire, a museum that renders willing service to the whole world. Not all of Dr. Bolton's suggestions will be accepted without qualification, but on this at least we shall be agreed : that one of the best ways of helping the museums of Great Britain and of the Dominions would be an expansion of the staff of the Natural History Museum. If Dr. Bolton is, as we think, right in his belief that museums can do much to knit more closely the brotherhood of the British Empire, then there could be no more secure investment for such funds as may accrue from "The Great Advertisement" at Wembley.

Electrothermic Processes of Steel Manufacture.

The Manufacture of Electric Steel. By Frank T. Sisco. Pp. x + 304. (London : McGraw-Hill Publishing Co., Ltd., 1924.) 15*s*.

UP to the present time several books have been written which deal with electric steel-making furnaces from the point of view of their electric, mechanical, and thermal efficiency. Not one of them, however, describes with any completeness the operation of the furnace and the making of a heat of steel. It has been evident for some time that this was greatly needed, for although the men directly connected with the manufacture of special steels are thoroughly conversant with the electric process and its advantages and disadvantages, those in the steel industry outside of this field have had very little opportunity of becoming familiar with it. In the present volume the author has endeavoured, with much success, to fill this need by discussing thoroughly the manufacture of electric steel, starting with the raw materials and ending with the teeming of the ingots. After the heat is poured and the ingots stripped, the furnaceman's duties are ended. If he has delivered a first-class ingot to the rolling mill or the forge, this represents his part of the effort necessary to the manufacture of a satisfactory product.

The electrothermic process of steel manufacture is the infant—a lusty one—of the iron and steel industry. Little more than twenty years ago the manufacture of steel by this process was still in the embryonic stage. To-day about 1200 electric furnaces are operating in America and Europe. The advance during the past ten years has been nothing short of astonishing, production having increased from 52,000 tons in 1910 to 502,000 tons in 1920. The recognised ability of this process to produce high quality alloy and tool steel ingots, and the superiority of the process over others in the manufacture of castings, is responsible for this advance. In view of the existing literature, the author has devoted comparatively little space to the description of the furnaces themselves. Even in the case of the Héroult furnace, which is the largest single producer of electric steel, manufacture and construction of the electrical details are only lightly touched on. In the United States of America, Héroult furnaces up to 30 tons capacity are in regular use, and are of a size comparable with open-hearth furnaces.

The electric furnace is unique in ferro-metallurgical processes in that it will produce a high-grade material in tonnage lots. The author claims that the same quantity of steel, say 30-50 tons, delivered by the open-hearth can be made in an electric furnace of a quality

qual to the best product of the crucible pot. One of he great advantages of the electric process is flexibility nd control. It can be operated with cold charges or ot metal. It can also be used for making pig-iron ynthetically or for refining molten cupola iron. The emperature can be controlled within a few degrees. Deoxidation and reduction can be carried to any lesired point and sulphur and phosphorus eliminated lown to traces. Compared with steel made by the pen-hearth or Bessemer process, electric steel has reater density and is much freer from slag and occluded r absorbed gases. It is stronger, tougher, and more luctile.

The outstanding disadvantage of the process is its ost. The author anticipates that this is destined to ecome a less serious handicap as power resources become more completely developed and economy of urnace operation is more thoroughly understood and ractised. Another disadvantage is that furnaces are ften operated by men unversed in deoxidation and hus a steel is produced which is not so good as it hould be. A more thorough training is required for he furnace operators. Moreover, electric furnaces are requently installed as adjuncts to open-hearth furnaces y companies interested primarily in the production of arge tonnages. The electric furnace occupies a field f its own and may, with the greatest economy and best results, be operated in conjunction with another melting operation, but should never be used as a subsidiary to it. To quote the author: "Washing hot metal in an electric furnace and calling it electric steel has done much to give it a bad name."

The chapter on the chemistry of the basic electric process is one of the best in the whole book. The author discusses fully and fairly both the oxidation and deoxidation periods. After deoxidation is complete and the alloy additions have been made, the hot metal lies in the furnace covered by a very basic slag containing up to 65 per cent. of calcium as oxide with 13 per cent. of calcium carbide. Through the agency of these, iron oxides and manganese oxide are almost wholly eliminated from slag and bath, the addition of ferro-manganese and ferro-silicon completing the elimination. The fusible silicates of iron and manganese formed in small amounts have had time to separate from the steel. Carbon monoxide gas has been eliminated by silicon, leaving in its place silica, of which a very small amount remains dispersed in the metal. Sulphur is present in the form of manganese sulphide to the extent of one part in five thousand. It is practically impossible to get it out of the steel. Gases should be almost entirely absent. Except, therefore, for small amounts of manganese sulphide and still smaller amounts of silica, the steel should be free from non-metallic inclusions. In these respects it is markedly superior to even the best open-hearth steel.

The author devotes some attention to the Austrian practice of melting chrome-nickel steel for aeroplane shapes. The charge is melted and refined with the idea of producing a so-called fibrous structure which, according to Kothny, is necessary to meet the Austrian army specifications. He challenges the practice *toto caelo*, and gives very good reasons for concluding that the fibrous condition formerly considered so beneficial to steel is in reality harmful.

Mr. Sisco, who is an American metallurgist, has written a valuable book, and by his own work in this subject is making an important contribution to placing the manufacture of electrothermic steel on a scientific basis. His style is clear and his language apt, and he emphasises his main points so that he may be thoroughly understood by men who operate furnaces. The book will also be of service to college students and young metallurgists for the clear picture it gives of the essentials of the best accepted practice in both basic and acid processes. H. C. H. C.

Tycho Brahe's Observations.

Tychonis Brahe Dani opera omnia. Edidit I. L. E. Dreyer. Tomus X. Pp. xxvii+434. (Hauniæ: In Libraria Gyldendaliana, 1923.) n.p.

THE Carlsberg Foundation and the president of the Royal Astronomical Society are to be thanked for presenting us with a most interesting, if not very readable book. The tenth volume of the works of Tycho Brahe is the first volume of his observations, and contains his observations down to the year 1585. The editor's prolegomena tell the history of the manuscripts in which these observations were recorded, of successive projects for their publication, and of the imperfect publications which have appeared. The obstacles to publication were not, it would appear, entirely material. We are quite accustomed to observations being made by one astronomer and theoretical deductions by another, and Ludwig Kepler's contention, thirty-six years after Tycho Brahe's death, that his observations should be reserved for the emperor alone and those to whom, as a special favour, he should grant the use of them, is what we should nowadays expect to find only in the case of discoveries of commercial value, not of astronomical observations. It will be noticed that the sole right to draw deductions seems to pass with the MS. observations after the observer's death. Happily, Kepler had been the owner, and these observations provided him with the material for his laws of planetary motion and his Rudolphine Tables.

There are two great MS. collections of Tycho's observations, both made under his own direction and both containing notes in his own hand. One, now preserved at Copenhagen, contains the daily or nightly record; the other, now at Vienna, arranges the observations of each year according to the bodies observed. Neither is quite complete. Dr. Dreyer has, where possible, followed the text of the Copenhagen and the arrangement of the Vienna MSS.

The one previous edition of any degree of fulness was that of Albert Curtz, which appeared in 1657–66, but it is defaced by many grave defects. It was based on what is now the Vienna MS. The numerous subsequent projects were based mainly on the Copenhagen MSS. or on Curtz corrected from those MSS. After an abortive project of the Royal Society in 1707, proposals for a complete edition practically died away, the one exception being Hvass's project to include the observations in a complete edition of Tycho's works in 1778. This was inevitable. The observations had for the most part come to belong to the history of astronomy. They had lost their living value. Pingré used for his "Cométographie" in 1783 a copy which Bartholin had prepared for printing and never printed, and the observations of comets were published in full by Friis in 1867. These observations at least could not be superseded.

The present most scholarly edition is probably to be classed as a work of piety rather than as a contribution to the progress of science. But without investigation it is impossible to say how far back observations are useful. A sign of the editor's extreme pains is that where there has appeared to be an error in the record of observations, he has attempted to discover its cause by means of computations.

The student of Tycho will find mixed with the observations mathematical constructions and discussions of the quantities dependent on the observations. These increase the interest of the book to any one who studies the history of astronomy. It would be useful to have in some later volume a glossary of star-names.

J. K. F.

A New Natural History.

The Animal and its Environment: a Text-Book of the Natural History of Animals. By Dr. L. A. Borradaile. Pp. vii+399+4 plates. (London: Henry Frowde and Hodder and Stoughton, 1923.) 18*s.* net.

EVERY zoologist will grant that animals should be studied in relation to their surroundings. Physiologically, as Huxley said, they are whirlpools in the river; morphologically, they are, in part at least, bundles of adaptations, definitely related to environmental conditions. Embryologically considered, they develop in a particular "nurture," and they may develop differently when the circumstances are altered. Etiologically, they must be considered in relation to environmental stimuli and environmental sifting; isolation is often an environmental affair; the pulse of evolution changes its throbs with the climate. Then there is the behaviour of the creature, so largely concerned with thrust and parry between organism and environment. In certain cases we are most impressed with the grip of the environment on the organism; in other cases, what strikes us is the dominance of the organism over its environment. As Prof. Patrick Geddes has neatly put it, life is a balancing between Organism→function→environment and Environment→function→organism

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All zoologists recognise theoretically the inseparability of the animal and its surroundings, but the truism has not always been evident in their books and lectures. Therefore one gives a hearty welcome to Dr. Borradaile's new natural history which definitely considers animals in relation to their environment. It may be regarded as a continuation of Semper's unsurpassed "Natural Conditions of Existence as they affect Animal Life" (1881).

The book begins by envisaging animals in their natural setting. The organism runs the gauntlet of physical influences and animate influences. There are relations between animals and plants, between animals and their kindred, between animals and other species, and between the sexes. It does not seem easy, if desirable, to separate the animate from the non-living environment; yet one feels that, just as with mankind, there is a difference between mutual relations among living creatures and the relation between living creatures and their *milieu*, or, let us say, climate. Anyhow, what we should call the more distinctive environmental note is sounded emphatically in the subsequent chapters dealing with the faunas of the sea, of fresh waters, and of the land. Then follow chapters on the evolution of faunas, migration, and internal parasites. The concluding chapter deals with the influence of surroundings upon the animal organism, a consideration of which lands the author in an unnecessary scepticism as to the organism's power of "real initiative."

Dr. Borradaile gives many familiar facts a new setting, but he has also a wealth of fresh material. All is presented clearly and educatively, with a generous supply of interesting figures. There are four very beautiful coloured plates. The book is to be strongly recommended in itself and as a supplement to other modes of treatment. There are very few words in

t that could be dispensed with, and we do not know hat the author could have used his space to better ffect, but we venture to suggest for a new edition hat more space should be given to the inter-relations etween plants and animals and to the seasonal changes f environment. Dr. Borradaile has deliberately re- rained from discussing theories of evolution (as to he steps and factors in the historic process), but we annot agree with his view that "these subjects are ut remotely connected with that of the relation etween the individual and its surroundings, which s best studied for its own sake." This seems like a eaction to biological statics, quite inconsistent with he temper of a very dynamic book. The existing elations between organisms and their environments nust, of course, be described and analysed, but sooner r later they must also be studied as historically letermined results. And in this inquiry the changes f environment from age to age must be appreciated. Prof. Huntington, thinking chiefly of the climatic factor in man's history, writes on "The Pulse of Asia"; the zoologist cannot afford to lose hold of his clue. There is a pulse in evolution.

In regard to the chapter on parasitism, where the author shrewdly recognises the heterogeneity of the phenomena, we think that he misses an opportunity of striking out from an outworn conventional concept. "Parasitism" is a too convenient label and it has been badly strained; there are (see Borradaile) at the very least half-a-dozen different kinds of parasitism. That seems to us to indicate the one-sidedness of the environmental grouping in general. Just as we have plankton and nekton in the open sea, illustrating one of the great organic dichotomies, so there is a sharp contrast between a tapeworm and a trypanosome. But we are not blaming Dr. Borradaile for the intricacy of Nature; we are rather, in our hyper-criticism, paying our best compliment to a notable new departure in natural histories. We hope it will have the great success it deserves.

Chemistry of Colloids.

Colloid Chemistry: Wisconsin Lectures. By The. Svedberg. (American Chemical Society Monograph Series.) Pp. 265. (New York: The Chemical Catalog Co., Inc., 1924.) 3 dollars.

COLLOIDAL solutions of the suspensoid type, although not always of immediate technical importance, have many advantages as material for the investigation of the quantitative factors in disperse systems. Sols can be prepared with particles of known and regular size, and, provided conditions of formation are carefully regulated, the systems can often be reproduced within quite narrow limits. The stability of these colloidal solutions does not depend to any great extent on the hydration of the particles, and is therefore not affected by the previous treatment of the solution to the same degree as in sols of the emulsoid type. Indeed, the suspensoids approximate most closely to the purely physical conception of a colloidal system as particles of small size dispersed in a pure continuous medium.

The numerous and fundamental researches of Prof. The. Svedberg have mostly been concerned with colloids of this type, and in the present volume, which embodies a course of lectures delivered at the University of Wisconsin in 1923, this work is summarised with copious references to the related discoveries of other investigators. The title "Colloid Chemistry" is thus misleading unless read with some emphasis on the subtitle. For example, only fifteen pages of the whole book are devoted to gels, and emulsions are scarcely mentioned at all. The author apologises for his bias in the preface, but it should have been indicated in the title of the book.

When, however, the restricted scope of the volume is realised, its value becomes greater than it would be if it were a more general treatise. The author is naturally impatient and distrustful of the merely qualitative or at best empirical experiments which are common in colloid chemistry, and so tends to confine his summary to accurate work on well-defined systems. The methods of formation are first considered and include an interesting account of the work of the author on the electrical dispersion process first worked out by Bredig. In this section the usual methods of purifying colloidal solutions are discussed, including several types of apparatus for electro-dialysis developed in the last few years. In the second part the colloidal particle is considered as a molecular kinetic unit, and the determination of Avogadro's number from the rate of sedimentation of these particles, giving values in remarkable agreement with those obtained by other methods, is described in detail. Among the methods by which the size of colloidal particles can be found is mentioned the calculation from the width of the lines in the X-ray diagram, which should prove a serviceable approach to this difficult determination in the future.

In the third section, under the title of "The Colloid Particle as a Micell," such subjects as adsorption, electrophoresis, coagulation and gel formation are introduced. This portion of the book is worked out in much less detail than the first two sections, and the author wisely refrains from dealing with the tangled mass of results which makes up our knowledge of the coagulation of colloids by electrolytes, and confines his remarks to fairly general statements. Peptisation,

again, with the mass of empirical information which represents practically all we know of that phenomenon, is dismissed in a single paragraph; and protection, of such great importance in technical work, is treated in an equally cursory manner.

It is, perhaps, unreasonable to expect a new branch of science to develop evenly in all directions, but in reading this book one is struck by the extent to which investigators in colloid chemistry have been occupied with systems in which water is the continuous medium. The extreme sensitiveness of aqueous suspensoids to slight traces of impurities, and the variation in properties of emulsoids with minute changes in the concentration of hydrogen and other ions, make the most heroic precautions necessary to avoid complete vitiation of results. The detailed study of non-aqueous and in particular of non-ionising liquids as the dispersion medium is now imperative, if only to clear up some of the results obtained with water. Prof. Svedberg's book indicates what can be done with fairly simple systems with specially designed apparatus, but we can look forward to results even more astonishing and important in the near future.

The author must be congratulated on writing so clearly in a language which is not his native tongue, and also on amplifying his narrative with more than a hundred excellent illustrations, most of which are original. The formal diagrams of the apparatus are frequently supplemented by photographs taken in the laboratory. It is a pity that the printing of the mathematical expressions is so amateurish, so that at times, as for example on pp. 94 and 151, the result is more decorative than intelligible. The value of the book to the scientific worker is increased by the selection of key references which is so constant a feature of the author's publications. For those without the time or opportunity to read the papers in the original, the volume provides an excellent summary of important work in the field with which it deals.

P. C. L. THORNE.

Our Bookshelf.

The Peaks, Lochs, and Coasts of the Western Highlands; Penned and Pictured with One Hundred Photographs. By Arthur Gardner. Pp. xi + 169 + 100 plates. (London: H. F. and G. Witherby, 1924.) 15*s.* net.

THE value of this work rests on its collection of photographs, most of which are excellent in quality and well illustrate the structure and character of the Scottish Highlands. The most beautiful are those of the western coast to the south of Skye. Those of the mountains in the interior have a certain monotony which is, however, instructive, as it represents the frequent recurrence of the same physiographic types. The text consists of an account of the author's journeys with hints to other photographers. The information is too indefinite to serve as a guide, and includes little as to the history, natural history, or geology of the country. The author expresses interested ignorance as to the nature of some of the rocks illustrated by his photographs, which might have been easily removed by reference to a geological map. He deplores the extent of the country devoted to deer forests, both on economic grounds and because they render much of it inaccessible during the usual holiday season. He laments the closing of inns which has rendered impracticable to most pedestrians some of the most beautiful routes across the country. The author also regrets the inconsiderateness of the landlords in planting the clumsy Austrian instead of the picturesque Scottish pine, from which it may be inferred that the author is a better photographer than forester. The book, as a useful collection of geographical photographs, will be of most interest to those who wish for a picturesque souvenir of the western Highlands.

The Hampshire Gate. By H. G. Dent. Pp. 179 + 14 plates. (London: Ernest Benn, Ltd., 1924.) 8*s.* 6*d.* net.

OF the southern inlets into England, physical circumstances have made the Solent and Spithead, with the valleys that give access to them, one of the most important. This may be termed the Hampshire Gate. Its value was very marked when Winchester enjoyed the full significance of its site as a focus of routes in southern England. The importance of Southampton dwindled with the Portuguese discovery of the Cape route to India, which involved the diversion of much Mediterranean trade, but eventually it revived with expansion of Empire and the growth of American trade. Miss Dent's book treats of the Itchen basin and is mainly a study in historical geography. The relation between physical conditions and trade routes is clearly shown. A considerable part of the book is naturally devoted to the port of Southampton. Winchester gets relatively little notice. The study, so far as it goes, is a useful piece of work, and is a good example of regional treatment in geography. The maps are small but clear.

History of the Great War, based on Official Documents. Medical Services: General History. Vol. 3: *Medical Services during the Operations on the Western Front in 1916, 1917, and 1918; in Italy; and in Egypt and Palestine.* By Maj.-Gen. Sir W. G. Macpherson. Pp. viii + 556. (London: H.M. Stationery Office, 1924.) 21*s.* net.

THIS volume deals with the medical arrangements of the War in France, Belgium, Italy, Sinai Peninsula, Egypt, Palestine, and the Senussi Expedition. Particularly detailed were the arrangements in the Somme battles of 1916, the advance to the Hindenburg Line (1917), Vimy Ridge (1917), Messines (1917), Ypres (1917), Hill "70" (1917), the German offensive of 1918, the Lys region, and the final advance to victory, ending with the occupation of Mons on November 11, 1918. Apologies are offered that the volume could not be made more attractive to general readers. It is hoped that omissions may be made good by a study of the maps and charts which are in profusion.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

The Pressure in the Reversing Layer of Stars and Origin of Continuous Radiation from the Sun.

THERE seems to be at present a wide divergence of views regarding the magnitude of pressure in the "reversing layers" of stars. While earlier investigators assigned to it a pressure of one to ten atmospheres, on the basis of pressure shift of lines to the red, these experiments do not appear to carry much weight at present. Fowler and Milne (Monthly Notices R.A.S., vol. 83, p. 415, 1923) actually assign to it a pressure of the order of 10^{-3} to 10^{-4} atmospheres.

The following speculations will show that probably an accurate method of determining the pressure may be developed from the limit of series absorption of elements in the Fraunhofer spectrum. To introduce the subject, let us start with the well-known fact that in the Fraunhofer spectrum of the sun the Balmer series of H absorption lines abruptly terminate at $H\zeta$, while in the flash spectrum no less than 35 Balmer lines are found. Here the ionisation theory does not help us, for all Balmer lines require the same H atom (in the diquantic state) for absorption. We are therefore confronted with the fact that as continuous radiation pours through the H(2) atoms, pulses which lift the electron up to the 8th quantum orbit are freely absorbed, but pulses which would lift the electron to the higher orbits somehow fail to be absorbed in spite of the presence of suitable absorption centres. Something prevents the development of the H-orbits beyond certain limits.

The next step is naturally to identify this agency with the congestion in the reversing layer due to high concentration of particles. In order that the nth-orbit may be developed, the electron should be capable of passing to an average distance of $0{\cdot}532 \times 10^{-8} \times n^2$ cm. from the nucleus. But if within this distance it comes under the influence of a second nucleus, or another electron, there can be no free development of the orbit: the electron will become either free, or attach itself to another nucleus. Hence for rays shorter than $H\zeta$, the H(2) atoms in the particular layers treated will lose their power of picking up the pulses corresponding to the Balmer series, but will exercise a sort of general, though much enfeebled, absorption on all radiation beyond $H\zeta$, somewhat after the manner of X-ray absorption. This part will be freely emitted only by higher layers, where the pressure has fallen to sufficiently low values; in other words, if the solar atmosphere were composed of H(2) atoms only, part of the continuous spectrum beyond $H\zeta$ would originate from somewhat higher levels than the redder part of the spectrum.

The idea helps us to get a clearer view of the origin of continuous radiation from the sun. For what has been said of H(2), absorption is a general phenomenon, and can be extended to all other elements. In fact a scrutiny of the Fraunhofer spectrum shows that quantum orbits higher than the 5th or the 6th (total quantum number) are rarely developed. The following examples illustrate the point :[1]

Element.	Last Series-line in the Fraunhofer Spectrum.	Corresponding Wave Number of final Orbit.
H	H_ϵ, $\nu = N\left\{\frac{1}{2^2} - \frac{1}{7^2}\right\}$	2238
	$H\zeta$, $\nu = N\left\{\frac{1}{2^2} - \frac{1}{8^2}\right\}$	1714
Na	$2p_1 - 6d$, $\lambda = 4668{\cdot}60$	3062
	$2p_1 - 6s$, $\lambda = 4751{\cdot}89$	3437
Mg	$2P - 6D$, $\lambda = 4351{\cdot}94$	3649
Ca	$2P - 4D$, $\lambda = 5188{\cdot}85$	6385
	$2P - 5S$, $\lambda = 4847{\cdot}29$	5028

For every one of these elements conclusions similar to that in the case of hydrogen hold. Thus, since the higher members of the series lines are in the ultra-violet, there will be cumulative continuous absorption on the short wave-length side. Hence, as a rule long waves will come from deeper layers, short waves from higher layers. How satisfactorily this view accounts for the distribution of energy in the solar spectrum will be evident from the following passage: "Both the observed curves of distribution of energy in the solar spectrum (by Wilsing and Abbot) agree in having a much more pronounced peak than the black body curve, in being depressed below the latter in the violet (*the drop of intensity on the violet side of the maximum being very sudden*), and in coinciding with the black body in the extreme infra-red" (Milne, Phil. Trans., A, vol. 223, p. 218).

Thus for different rays we have different photospheres, but the distances separating the extreme photospheres probably do not differ by so much as 100 km. The photospheres and the reversing layers thus get very much mixed up. Owing to the rapid density gradient of luminous matter (except probably in the case of such atoms as are maintained by selective radiation pressure) the luminosity of the concentric layers round the sun decreases very rapidly. For example, it is well known that if, when obtaining the Fraunhofer spectrum, exposures of longer duration than 1/100 sec. are given, there is no contrast, all dark lines becoming bright. But to obtain the spectrum of layers about 100 km. from the disc during total solar eclipses, exposures of 4 to 10 sec. are required. This shows that the so-called dark lines of the Fraunhofer spectrum are intrinsically 100-1000 times more luminous than the bright lines of the flash. Hence when we expose for the Fraunhofer spectrum, the time of exposure is too short for the chromosphere, which does not, therefore, contribute anything to the resulting photograph. In other words, Fraunhofer absorption is caused by layers close to the disc, the higher chromosphere contributing nothing to the process.

These ideas may be extended to stars. According to a rough calculation, if n is the quantum number corresponding to the last absorption line of the Balmer series in a star, $n \propto \left(\frac{T}{P}\right)^{\frac{1}{8}}$. I have been able to collect the data for three A-type stars, α Cygni (ab. mag. $-4{\cdot}5$), α Lyræ (ab. mag. $+0{\cdot}6$), α Canis Majoris (ab. mag. $+0{\cdot}9$). In α Cygni, 24 Balmer lines are developed, in Vega 17 (up to $H\rho$), and in Sirius 13. Now α Cygni is a typical giant star, Sirius is a typical dwarf, and Vega lies between them. It is generally admitted that the pressure in the reversing layer of giants is much lower than in dwarfs, and hence the great development of Balmer lines in α Cygnus can be easily understood. Sirius also shows more Balmer lines than the sun, and this is to be ascribed to the joint action of higher temperature and lower pressure in its atmosphere.

For an exact estimation of the pressure from such

[1] See Russell, *Astrophysical Journal*, vol. 55, p. 130. According to some authors, H_ϵ is the last absorption-line of the Balmer series. It is always difficult to trace the last line, as it is usually very faint.

data we must wait for further theoretical and experimental work. Much of the idea contained in this communication is to be found in papers by Fowler (*Phil. Mag.*, vol. 45, p. 20), Urey (*Astro. Journ.*, Jan. 1924), Wright (NATURE, vol. 109), Becker (*Zs. f. Physik*, vol. 18, p. 335).

MEGH NAD SAHA.

The Indian Institute of Science.

IN the first column of his article on chemical research in India, in NATURE of June 28, Prof. Thorpe makes reference to the past history of the Indian Institute of Science. I held the office of director for the first half of the period since it was created; and I am glad to have an opportunity of relating the facts with regard to the Institute, now that it is "under the new regime."

In the first place, the term "original purpose" requires some explanation. The proposal to establish a "university of research for India," by the late Mr. J. N. Tata, goes back to the opening of Lord Curzon's viceroyalty, when the matter was first brought to the notice of Government. After much discussion between Mr. Tata and the Government of India, matters took a practical turn when, in the cold weather of the year 1899–1900, Sir William Ramsay went out to India, on the invitation and at the expense of Mr. Tata, to advise on a scheme. Sir William advised in favour of establishing an institution with nuclear departments of chemistry, engineering, and applied bacteriology, but suggested that the main work of the organisation should be to develop industries directly, and that projects should be taken up, developed until they arrived at a paying stage, and then handed over to commercial concerns. The Government of India rejected this suggestion as altogether unsound, and I entirely agree with their conclusions.

Professor (now Sir Orme) Masson and Col. Clibborn, principal of Rurki Engineering College, were then asked to report upon Mr. Tata's scheme, and to make recommendations as to carrying it out. They drew up an eminently practical report, recommending the establishment of nuclear departments, a library, etc., much on the lines of Sir William Ramsay's report, but pointing out that the function of the Institute should be restricted to the provision for advanced study and research. The only section of the report with which I am in disagreement is the building proposals, which, as Col. Clibborn afterwards told me, were drawn up rapidly, and were not checked. The report was accepted by the Government of India and by Mr. Tata.

In August 1906 I was offered the appointment of director, being informed by letter by the Secretary of State for India that "in accordance with the will of the late Mr. J. N. Tata" it was proposed to found an institution for advanced study and research, particularly in applied science; and, on accepting the appointment, I was given copies of printed minutes of the Government of India, setting forth the whole story of the Institute, and confirming the idea that the report of Masson and Clibborn had been definitely accepted and must be considered the basis of the organisation which I had to develop.

I did not know until I arrived in India a few months later that Mr. Tata's heirs held a view of the matter different from that which had been communicated to the home Government. They held, in spite of the opinion of the Advocate-General, Bombay, that they were not bound by the will to carry out the scheme agreed upon by Mr. Tata and the Government of India, and they had informed the Government of India that they were only prepared to proceed with a scheme which left in their hands a measure of control far beyond that claimed by Mr. J. N. Tata at any time. In a note on their proposals, Lord Curzon had pointed out that they wished to establish a private institution financed out of the public funds.

Though working compromises were arrived at from time to time, it was not until 1910 that the matter was settled, and then settled on unsatisfactory lines; for to the constitution, as finally adopted, Lord Curzon's criticism might well apply. Further, all agreements prior to Mr. Tata's death were cancelled, and the representatives of Mr. Tata's heirs declared their intention to use every effort to divert part of the funds of the Institute, and the whole of the accumulated balances, which alone were available for properly equipping laboratories, to the establishment of departments dealing with "social and economic studies." Actual and definite proposals for the creation of departments of social and political history, and of certain medical studies, were put forward, and I have masses of documents dealing with these matters. Thanks to the support which I received from the then Resident in Mysore, and to the then Dewan of Mysore, I succeeded in resisting these proposals; but this gave rise to resentment, and before the end of 1909 I well knew that I should have my work cut out to hold on to my post for the eight years of active service in India for which I was appointed.

On the basis of compromise we had begun building operations in May 1908, and a provisional committee was appointed on which the Tata family was represented. The committee did not, however, support the idea of establishing departments of social studies and was wrecked before the end of the year. Since however, small contracts which the committee had entered into were still running, Government requested me to carry on. In the autumn of 1909 a provisional council came into existence. I laid before this body proposals based upon the Masson and Clibborn scheme, which had been agreed to in Mr. J. N. Tata's lifetime. An attempt was made to modify it with the view of including social studies, but the majority was against the proposal. The provisional council then entered into contracts for building, etc., amounting to more than 100,000*l.*, and all appeared to go well. However, the political element were not to be beaten. They found a flaw in the constitution of the council, and in May 1910 I was informed by Government that I must spend no more money until certain legal formalities had been completed.

I believe that I should have been well advised if I had cancelled all contracts, dismissed my office staff, etc., and shut down. Such a course would have been officially correct, but contrary, at least, to civilian tradition in India. It was clear that Government dare not help me. The Bank of Madras did, however, come to the rescue, and I was prepared to risk accepting loans on my own account. I carried on for five months; but I knew that the resolution of thanks passed by the reappointed council was not an unanimous resolution of good-will.

By July 1911 the laboratories, etc., were sufficiently advanced to allow of students being admitted, and the Institute actually opened. For a moment the future looked promising, but not for long, for difficulties arose in which the later failures, now to be corrected by "the new regime," found their origin. In their report, to which I have already referred, Masson and Clibborn pointed out that trouble would undoubtedly result if members of local educational and scientific services were elected to the governing body, as interests were certain to come into conflict. Were the Institute to develop on the lines they (Masson and Clibborn) laid down, and provide facilities for stu-

and research in pure and applied science, it must necessarily come into conflict with the interests of the University of Madras. On the other hand, the departments of industries of Madras and Mysore might find in its staff and laboratories the means of developing their industrial projects. Actually, before I left for home on leave in April 1912, I found that the political opposition had added to itself a service opposition, opposed to carrying out the policy of the Masson and Clibborn report, and supporting the idea of developing the Institute on industrial lines. The position was fairly hopeless, and before leaving for home I laid the whole matter before the Education Department.

During my absence from India an unexpected development took place. In the month of September I received a communication embodying what was said to be a resolution of the council, asking for an explanation on certain matters connected with the building operations, but couched in such language that I could only return to India by the next mail, and proceed directly to Simla, where I asked that a full inquiry into my administration of the Institute should be held with as little delay as possible. I was received most sympathetically, and I was informed that notes on the matter were in my favour, as it was obvious to the authorities that an attack on me had been organised by my staff. I doubted it, but returned to Bangalore to find out. I then learned the following facts. The resolution had been compiled by the official members of the council. It had been read through, or had been said to have been read through, at a council meeting, and passed; but a legal member of the council, on receiving a copy of it, stated in writing that he did not recognise it, and that it prejudged every issue that it raised. I further learned that the officials would oppose an inquiry; and later, when the Viceroy, as our Patron, ordered that an inquiry should be held, and that in the meantime I should return no explanation in answer to the resolution, they flouted his authority, demanding an explanation of me, and when I refused to comply, they addressed a communication to the Education Department recommending that I should be removed from my office without any inquiry being held.

The inquiry was held in May and June of the following year (1913). It was a lengthy business. Every one who had ever been connected with the Institute was asked to come to Bangalore, and to give evidence, but not on oath. I was not asked to be present, and I heard none of the evidence, and yet the terms of reference were "to inquire into the conduct of the director." Towards the end of June I was invited to meet the committee, and to tell the story of the Institute down to the year 1911, but not later. Before the committee broke up I was sent for, and told that it proposed to give me the substance of its report to the Viceroy. What this amounted to was this,—that on two occasions I had failed to circulate papers to the Council, and that I should cultivate better relations with the political element. The matter about the papers had come out in evidence, but I pointed out that the records would show that it was untrue. The second item involved acceptance of the scheme for political studies, which would have brought me into direct conflict with Government. I had been warned to this effect the day I landed in India.

It did not need the assurance of the Indian official who acted as secretary to the committee—I can mention the matter at this distance of time—to make it perfectly clear to me that the attack which the official members of the council had led against me had failed completely; but I knew perfectly well that as a non-official I could not win in this conflict. That the Education Department was in a dilemma was obvious, and contrary to the hopes of my official opponents they made no move until, in the month of September, they wrote me about a further money grant for the completion of certain buildings. It was clear that they wished the matter to be dropped; but a fresh outburst on the part of the official members of the council, who complained that the result of the inquiry had not been issued, resulted in a telegraphic summons to me to go to Simla. When I arrived there I was informed verbally that the situation could only be solved by my resignation, and it was suggested that I should retire on my pension at the end of the following March. The prospect of release was inviting; but on my return to Bangalore a document came into my hands, practically by accident, which put an entirely new complexion on the matter. It was a copy of a printed minute of Government, dealing with the inquiry, and containing all that Government dared say about it, and a great deal more than it dared publish. With reference to myself, it was the finest testimonial I ever received, and if I ever destroy the rest of the vast accumulation of papers relating to this business, I shall keep it as such. However, it showed that, following my resignation, it was proposed to dispense with the services of two members of my staff, who were not, knowingly, the subjects of the inquiry, and a third was to be removed to Madras to avoid competition between his department and a somewhat similar but inferior department in a Madras institution. I at once informed Government that I would not resign upon any terms.

However, my position was an intolerable one, and it was clear that if I stayed on I should have to carry out a policy which I believed to be wrong. Even the stimulus of fighting against it would be lacking. I therefore intimated my willingness to resign, provided that my colleagues were satisfied. Two years' furlough, followed by pension, were actually due to me, and I only asked that the circumstances of my resignation should be made clear in a *communiqué*. This was agreed to, but the *communiqué* was never issued. The late Prof. Rudolf, professor of applied chemistry, agreed to accept six thousand pounds by way of compensation, and he was appointed honorary technical adviser to the Institute, and the other proposed removals were cancelled. Prof. Rudolf left India in March (1914), but I did not get away till the end of June, exactly two years after the passing of the resolution which gave rise to the trouble.

Within a few months an official ex-member of the council was appointed to the vacant post of director. The new day dawned, but the afternoon seems to have clouded up rather badly.

The "new regime" will have found buildings, equipment, and organisation much as I left them at the end of eight somewhat strenuous years, and for which I had to beg most of the money. It will have found a policy against which I fought, losing the battle and also my appointment at the same time. Had I been contented to adopt a policy of *laissez-faire* I should have had an easier time. I might even have earned the commendation of the powers, at the expense of my own self-respect. It now remains for the "new regime" to sweep away the rubbish and carry on from where I left off. If this is done I shall have nothing to regret.

MORRIS W. TRAVERS.

23 Stafford Terrace, Campden Hill, W.,
June 28.

DR. M. W. TRAVERS knows better than any one else the inner history of the events he describes. The report of my committee dealt with conditions as we found them, and the recommendations were made with the sole object of indicating a remedy for the very unsatisfactory industrial condition in which

India now finds herself. No one who has visited Bangalore can have failed to recognise the great pioneering work which Dr. Travers did there; but the fact that he was unable to carry through does not necessarily mean that, under different conditions, possibly determined by past experience, the outcome might not be different. JOCELYN THORPE.

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South Kensington, London, S.W.7.

Some Poetic Allusions to Phenomena of Plant Biology.

IT is with a peculiar pleasure that one finds observations, ordinarily recorded in the precise words of scientific usage, appearing in the beautiful and fanciful diction of the poets. The following examples may be familiar to many, but I have not seen them mentioned elsewhere in this connexion.

It has been shown by A. R. C. Haas that the soluble pigments in many flowers act as indicators, and give a measure of the hydrogen ion concentration of the sap, which in some flowers becomes less as the petals age and wither. This colour change has been noted by Edmund Spenser, and in recent times by A. E. as follows:

Astrophel.

Transformed them, there lying on the field
Into one floure that is both red and blew;
It first grows red, and then to blew doth fade,
Like Astrophel, which thereinto was made.

The Great Breath.

Its edges foamed with amethyst and rose,
Withers once more the old blue flower of day:
There where the ether like a diamond glows
Its petals fade away.

The first is the imagery of mythology, the second uses the same illustration to contrast the brief life of a flower with the unending procession of days.

Again Tennyson gives us a description of the yew tree in stanza 2 of "In Memoriam," which contains these lines:

O not for thee the glow, the bloom,
Who changest not in any gale,
Nor branding summer suns avail
To touch thy thousand years of gloom.

Beyond this stanza the early edition makes no further detailed reference to the yew. Later editions, however, provide one additional stanza, a new thirty-ninth being intercalated.

Old warder of these buried bones,
And answering now my random stroke
With fruitful cloud and living smoke,
Dark yew, that graspest at the stones

And dippest toward the dreamless head,
To thee too comes the golden hour
When flower is feeling after flower;
But Sorrow—fixt upon the dead,

And darkening the dark graves of men,—
What whisper'd from her lying lips?
Thy gloom is kindled at the tips,
And passes into gloom again.

Here Tennyson guards against the too literal interpretation of "who changest not in any gale," and gives a wonderful description of the liberation of the pollen and its result of many months later, the formation of the red berry, red as a glowing tip on a piece of wood kindled by fire. The berry falls, the glow is quenched, and gloom follows. This natural sequence of pollen and berry, coupled with the use of the word "kindled," so suggestive of a fiery hue, makes it seem impossible that Tennyson can have intended to allude to the lighter green of the young leaves—an explanation which, I believe, has been put forward.

To A. E. again we are indebted for the description of the recovery of turgor in plants wilted by the heat of day, which is contained in "A Summer Night":

The falling of innumerable dew,
Lifts with grey fingers all the leaves that lay
Burned in the heat of the consuming day.

We have all seen the "grey fingers," but it takes a poet to stamp the picture in an untarnishable phrase.

Finally, in "Prometheus Unbound," Shelley alludes to the liberation of oxygen in photosynthesis, imagining that the spirits "Which make such delicate music in the woods" dwell in bubbles, thus:

The bubbles, which the enchantment of the sun
Sucks from the pale faint water-flowers that pave
The oozy bottom of clear lakes and pools,
Are the pavilions where such dwell and float
Under the green and golden atmosphere
Which noon-tide kindles thro' the woven leaves;
And when these burst, and the thin fiery air, . . .

Have we as yet got so very far beyond "the enchantment of the sun" as an explanation?

W. R. G. ATKINS.

Antony, Cornwall,
July 17.

Electrical Properties of Thin Films.

THE mechanical properties of thin films on the surface of water have been the subject of many investigations; yet little is known of their electrical properties. Whilst the electrical properties of those films which are formed on the surface of soluble capillary active substances can be readily investigated using a method elaborated by Kenrick (*Zeitschr. f. physik. Chem.*, xix. 625), no method, so far as I know has yet been described which can be applied to

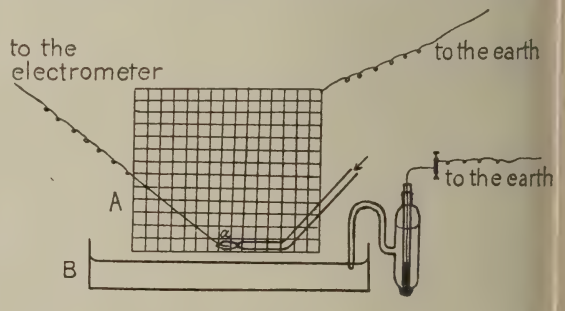

FIG. 1.

films formed by insoluble substances. The following simple arrangement has been designed which has given quite satisfactory results in this case.

A thin platinum wire *a* was heated to white-heat by a minute gas flame in an earthed Faraday cage *A* hung over the surface of water in the vessel *B* (Fig. 1). The platinum wire was connected with a quadrant electrometer, and the water in the vessel with the earth through a decinormal calomel electrode. Between the earth and the electrode, a variable electromotive force could be inserted. The experiments have shown that the potential of the wire follows closely the variations of the potential of the water surface when the distance between the platinum wire and the water surface does not exceed 7-8 mm.

If we put now a droplet of oil on the water surface the electrometer shows instantly a change of the potential of the wire. In order to compensate this

change a definite electromotive force has to be inserted between the calomel electrode and the earth. In this way it can easily be shown that a monomolecular layer of oleic acid makes the water surface more positive by 0·22 volt, whereas the same effect for lauric acid amounts to 0·27 volt and for olive oil to 0·33 volt. On replacing the water in the vessel by a solution of a capillary active substance, data are obtained which can be compared with those given by the Kenrick method. In this way I have found a positive effect equal to 0·27 volt for 50 per cent. acetic acid and a negative one equal to 0·38 volt for a molar solution of chloral hydrate, whereas the Kenrick method gave for the same solutions in a fair agreement +0·285 and −0·365 volt respectively (*Zeitschr. f. physik. Chem.*, in press).

The experiments are to be continued, and a detailed account will be published in the *Zeitschr. f. physik. Chem.*

A. FRUMKIN.

Karpow Chemical Institute,
Moscow, July 3.

The Oogenesis of Lithobius.

MISS S. D. KING in her note on the oogenesis of Lithobius published in NATURE of July 12, p. 52, says:

"Yolk formation is from nucleolar extrusion, of which two phases can be distinguished; first, an early extrusion of particles budded off from the large central nucleolus, which retains its individuality, and, secondly, an extrusion of particles derived from the fragmentation of this nucleolus."

In a paper on the oogenesis of Lithobius now in the press (Proceedings Cambridge Philosophical Society), I have shown that there is no fragmentation of the nucleolus. It can be seen in the most highly developed oocytes obtainable from the ovary as a completely acidophil structure with prominent vacuoles. The nucleus at this stage lies just below the chorion. As to budding of the nucleolus, there are two kinds of nucleolar extrusions: small circular bodies, which generally form the secondary nucleoli, and large irregular bodies, which are first plastered round the nuclear membrane, where they may bud off smaller pieces, and are later detached and lie in the cytoplasm.

Nor is there any direct evidence for the statement that "the later extrusions enlarge after proliferation to form the definitive yolk spheres." All that can be said with certainty is that the nucleolar extrusions precede yolk formation, although a few may exist side by side with yolk spheres.

With regard to the Golgi apparatus, I have definitely established that during fragmentation it undergoes fatty degeneration, and gives rise to fatty yolk, which forms the uppermost area in the centrifuged egg, whereas the true vitelline yolk is thrown down. Both direct and indirect evidence has been adduced in favour of this statement. The fatty yolk is intensely blackened by chrome-osmium alone; with Da Fano it turns brownish. The mitochondria, the nucleus, and a few unchanged Golgi elements form the central area of the centrifuged egg.

In view of the remarkable transformation of the Golgi elements in the oocytes of Lithobius, which is paralleled only in Saccocirrus (Gatenby), and also in view of the egg-like giant spermatocytes of Lithobius, it was considered desirable to extend the investigations to the Golgi apparatus in the male germ cells. No fatty degeneration of the apparatus takes place in these cells. In the spermatogonia the apparatus consists of at least one circular element, in the centre of which is a definite archoplasm. During the remarkable growth phase the circular element proliferates profusely, so that the spermatocytes are full of such elements. Each circular element may also divide in such a manner as to form two very regular crescents, each with an archoplasm. During meiosis the distribution of the Golgi elements is quite haphazard. During spermateleosis all the mitochondria and the majority of the Golgi elements form the tail sheath, but a few Golgi elements are plastered round the anterior face of the nucleus, and probably give rise to the acrosome.

VISHWA NATH.

Zoological Laboratory,
Cambridge, July 14.

Approximate Rectification of the Parabola.

RECENTLY I had to ascertain with some precision the length of the curved path of a shot in air at elevations up to 40° as compared with the horizontal range.

The material available was a quantity of trajectories worked out in full detail by "small arcs." The error in summing these small arcs and considering the result to be the length of the curved path was within ±0·10 per cent. The greatest heights were also contained in the calculations.

Assuming the parabola of equal angle of projection and of equal height as standard and comparing the actual length, the length of a similar circular arc and the "fudge" formula $L = R \sec E$ to this standard, the result is surprising, and is as follows in parts *per thousand*:

Elevation in Degrees.	10	20	30	35	40
Parabolic error	0	0	0	0	0
Actual length	+1·0	+4·5	+7·0	+ 8·5	+ 8·5
R sec E . .	0	0	0	+ 0·8	+ 4·5
Circular arc .	0	+2·0	+10·0	+18·0	+31·0

On comparing notes with professional ballisticians, I cannot find that the "fudge" R sec E was known to Tartaglia, Galileo, Newton, or Benjamin Robins, nor has it yet been found in any modern book on ballistics or geometry. I hit on it myself by pure chance. Can any reader of NATURE supply a reference?

J. H. HARDCASTLE.

13 Charlton Road,
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Electric Charges by Friction.

THE following quotations from a book printed nearly one hundred years ago (Murray's "Elements of Chemistry." Sixth edition, Edinburgh, 1828) bear on the observations of an anomaly in frictional electricity referred to recently in NATURE (June 21, p. 914). "A white silk ribbon rubbed against a black one becomes positively electrified; but if the black ribbon be worn so that the colour is faded, and if the white ribbon be heated, the latter will be found to be negative, and the black positive."

As a result of consideration of a large number of such experiments, M. Coulomb inferred "that where the particles suffered a transient compression, they would be more disposed to become positive; where they suffered dilatation, the tendency would be to the reverse state."

This inference seems to receive support in the recent experiments with rough and smooth ebonite rods.

H. E. GOODSON.

38 Chapel Lane, Armley, Leeds,
July 4.

The Radioactivity of the Rocks.[1]

By Prof. JOHN JOLY, D.Sc., F.R.S.

THE subject of the radioactivity of the rocks is one whch offers to the geologist considerations of the first importance respecting the history of the surface features of the globe. To the chemist it offers considerations even more fundamental in character, for it appears to throw a certain amount of light on the past history of the chemical elements during geological ages—knowledge attainable in no other way at the present time.

The fact that the radioactive elements of the uranium family are widely, indeed universally, distributed in the rocks was determined, in the first instance, by the present Lord Rayleigh, who in 1906 published an extensive research on rocks of various kinds. Later it was found that elements of the thorium family are just as widely distributed; and further, it was found that there appears to be a certain well-sustained relation between the amounts of these elements present in igneous rocks when the uranium and the thorium content of the same chemical division of the rocks are compared.

Lord Rayleigh in his earliest paper came to the conclusion that the acid rocks contained more radium than the basic rocks. This result has been confirmed by subsequent work. He found that the mean content of the igneous rocks was considerably greater than that of the sediments. This result, which has also been confirmed, throws light on the high radioactivity of the more slowly collecting oceanic deposits—the red clay and the radiolarian ooze. Similar results have been arrived at for the thorium content of rocks.

I have already referred to the fairly constant ratio which exists in the quantities of uranium and thorium in igneous rocks. When we estimate the uranium from the radium, using the equilibrium factor $3{\cdot}4 \times 10^{-7}$, we find in basalts about $0{\cdot}44 \times 10^{-5}$ gm. of uranium and $0{\cdot}9 \times 10^{-5}$ gm. of thorium. In intermediate rocks the corresponding ratio is 0·76 : 1·64. In the acid rocks (granites) the ratio is 0·8 : 2·0. For acid intrusives it is 1·1 : 2·3. The mean of all acid rocks affords 0·9 : 2·0. In short, we find a ratio which does not vary much from 1 : 2. In individual rock specimens this ratio is often seen to hold; but exceptions are found. It is best revealed in the general means, as, under the conditions, might be expected. To what may this fairly constant ratio be ascribed?

The rate of decay of uranium is nearly three times as fast as that of thorium. Obviously the precise numerical value of the ratio referred to must have been changing throughout geological time and must continue to change. The uranium will have dwindled to insensible amounts long before the thorium. But the fact that there appears to be a numerical ratio which is preserved through the chemical divisions of the rocks, although the actual amounts involved may differ largely, must be significant of some controlling condition.

Now if all rock families derive their origin from some world-magma by certain processes of differentiation which do not select between the parent radioactive substances, uranium and thorium, then we can account for the observed constancy of ratio. For if granites, for example, take from the parent magma a certain quantity of both the parent radioactive elements without disturbing their primal ratio, and if diorites and syenites take a different quantity, but still without disturbing the original ratio, then in subsequent ages the ratio of uranium to thorium, varying in the same manner both in granites, diorites, syenites, and the mother magma, will continue to be alike in all.

This subject naturally leads us to the interesting conclusion reached by Lord Rayleigh that the first formed silicate in rocks—zircon—is most exceptionally rich in radium. We seem to know little about mineral genesis in rocks. Hence we find here a tempting field for speculation. The oxide of zirconium is isomorphous with the oxides of uranium and thorium. It seems probable that herein is some explanation of the accretion by zircon of radioactive elements from the magma. The radioactive centre thus originating becomes the centre of a minute field of intense ionisation. These conditions may be supposed to be favourable to the crystalline growth of molecules around it. The radioactive nuclei are small and their field of influence is restricted, but the surrounding chaos is trembling on the verge of equilibrium and there is unlimited time. Of the chemical effects of radioactivity Soddy says: "The great chemical reactivity of otherwise inert substances in presence of the radioactive materials must always be remembered in the interpretation of their action." In fact it has been supposed by workers on this subject that there is first a dissociation of molecular aggregates and temporary formation of free atoms under the influence of the radiations, rendering the substance highly reactive, as in the nascent state. Much experimental evidence for this statement might be quoted. In some such way the growth of mica or hornblende around zircons may originate.

This concentration of radioactive elements gives rise to the radioactive haloes found in certain rock-forming minerals of early consolidation—notably the brown micas. These very beautiful manifestations of radioactivity in the rocks raise many questions. It is remarkable that the earlier observers regarded these minute objects as organic in origin. The only basis for this view appears to have been their behaviour when the containing mineral was heated to a high temperature. The halo then vanished or lost all definition.

Far-fetched as such an explanation may appear, we must remember that the real history of these objects was at that period absolutely undecipherable. It required a generation of scientific discovery and the brilliant advances which brought to light radioactivity, the transforming atom, and the phenomena of material radiation, before the real explanation was possible. Sollas, before the period of these discoveries, suggested that they were in some way caused by the presence of rare elements in the nuclear zircon which is in most cases to be found in the halo. To go any nearer to the truth was then impossible. The

[1] Hugo Müller lecture (slightly abridged), delivered before the Chemical Society on February 28.

wonderful similarity of dimensions and structure revealed by these objects seems to have escaped notice.

With the advent of radioactivity the explanation is simple. In this new domain, which borders at once upon radioactivity, chemistry, petrology, and geology, many curious facts have come to light. For the first time we can determine by direct visual observation the presence of radioactive elements in the rocks, and, given the halo, a single measurement of its radius tells us at once whether it was generated by uranium or by thorium. Some haloes there are which are generated in a curious way from the passage of the gaseous emanation of the uranium family which has wandered from the radium whence it originated and has become occluded in certain nuclei. These then have become centres of development of haloes possessing characteristic dimensions telling of their exotic origin. These are the only three sorts of haloes reconcilable with the known sources of radioactivity.

It is desirable to recall here the foundations upon which our knowledge of haloes is built. The fundamental assumption is that the α-ray is the all-sufficient source of the halo. For example, the atomic *débâcle* from uranium to lead takes place in fifteen stages. Of these, eight are attended by the expulsion of a helium atom as an α-ray carrying a charge of two units of positive electricity. The range in air of these rays varies from 2·7 cm. (in the case of the ray from uranium-1) to 6·97 cm. (in the case of radium-C_1). If the atomic disintegration occurs within a mica flake, these ranges are reduced some two thousand times.

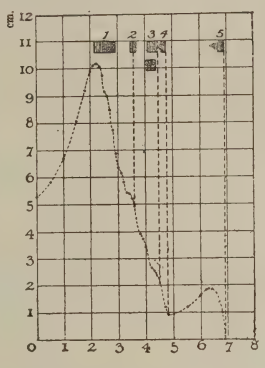

FIG. 1.—Ionisation curve for uranium haloes.

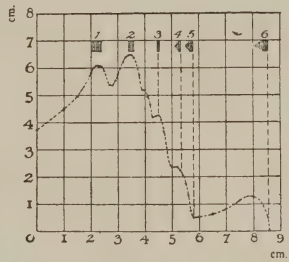

FIG. 2.—Ionisation curve for thorium haloes.

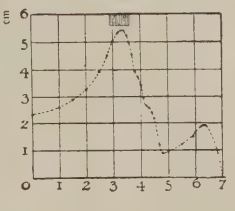

FIG. 3.—Ionisation curve for emanation haloes.

We know something about what happens along the track of the ray in gases. The particles of the gas are ionised. Bragg plotted the curve of ionisation. He found that the curve was alike in form for α-rays of long range and of short range, and that the ionisation rapidly increased just before the ray lost so much of its kinetic energy as to be no longer effective. The range of the ray is measured to the point where—effectively—it comes to rest.

Suppose now that in the brown micas the ionisation is attended with certain chemical changes—for example, affecting the iron present—so that the mica is darkened in colour. Then this darkening intensifies along the path of the ray and is darkest just at the approaching end of its trajectory. If uranium is contained in a minute particle—a crystal of zircon most generally—the eight rays will all act upon the surrounding mica within a certain spherical volume which has the zircon at its centre and the outermost boundary of which is defined by the path of the helium atom discharged from radium-C_1, the most penetrating of the rays. The radius of the uranium halo will therefore be about the two-thousandth part of 6·97 cm.—or, say, 0·035 mm. In the case of an emanation halo the outer dimension will be the same, for the penetrating ray of radium-C_1 decides its boundary, but the effects of the four least penetrating rays of the uranium family will be absent. If thorium be in the nucleus, then seven rays operate on the mica and the outer dimension is determined by the range of thorium-C_1, which is 8·62 cm. in air and becomes 0·041 mm. in biotite. Uranium and thorium haloes are thus readily distinguishable.

To determine the inner features, we lay out the ionisation curves of the eight rays of the uranium family, or the seven rays of the thorium family, or the four rays which generate the emanation halo and add the ordinates at sufficiently close distances. This gives us the integral curves of ionisation, and these curves we find bear close comparison with the actual halo. The apices of the curves correspond to the rings of darkened mica which lie around the nucleus. The depressions of the integral curve are depicted in the mica as annular areas of feeble darkening. But here a difficulty arises. Our method of arriving at these curves assumes that the rays affect the mica as if they travelled in parallel lines. But in fact they diverge, and when we plot the integral curve so as to allow for this divergence, we get a curve not at all accordant with the halo.

In order to explain why the halo does not exhibit the effects of the divergence of the rays, we may assume that something like photographic reversal or solarisation occurs when one ray traverses the path followed by a preceding ray. This weakens the density of the inner parts more than it affects the outer parts of the halo, and it follows that the ultimate effect is much the same as if the rays had been parallel. This view also explains the early appearance of the outermost ring of all; for a minimum of reversal affects this. It is not at all an improbable assumption that reversal plays an important part in the generation of the halo as we see it.

We see, then, that we can foretell the appearance and dimensions of the inner parts of a halo according as it originates from uranium, thorium, or radium emanation. If we find haloes not in accordance with these dimensions, we must conclude that we are dealing with new radioactive elements, unless some means of reconcilement be forthcoming. Herein we find an important application of the radioactivity of the rocks to the advance of chemical science.

When we look at the integral curves of uranium, thorium, and emanation haloes, we see that in the case of uranium and emanation (Figs. 1, 2, and 3) a single conspicuous crest occurs which must appear in

the halo as an inner ring of small radius. In the case of thorium, two such crests appear close together. Those early rings are the first appearance we find. Their measurement will tell us what elements we are dealing with, although the halo is only in an incipient stage of development. Such rings are found well developed and easily measurable around nuclei of extreme minuteness.

We possess in haloes a means of identifying the presence of radioactive substances in rocks which much transcends in sensitiveness any other known method. The electroscope transcends in sensitiveness chemical gravimetric methods of detection many thousands of times. The billionth of a gram of radium per gram of rock may be detected by the electroscope. But we may have a zircon nucleus of the five-thousandth of a millimetre in diameter. We may suppose it endowed with a radium richness twenty-five times as great as obtained in the richest zircons measured by Lord Rayleigh. Then the mass of radium involved is only 3×10^{-18} gm. or the millionth of the billionth of a gram. Such nuclei may show a perfectly measurable and identifiable ring.

The reason for this extraordinary sensitivity is obvious. The halo is always old—often very old, and through all the successive ages of geological time the ionisation effect is slowly adding up. It is, in fact, not found in the younger rocks. We perceive the final effects of such feeble radiation exactly as we may detect on the photographic plate, after long exposure, stars which are for ever invisible to the eye.

On this account, also, the halo is important to chemical science. It gives us a means of exploration, almost uncanny, into the past history of the chemical elements. By its help we may answer questions which may not be approached in any other way. We can tell if the known radioactive elements formerly differed in their mode of disintegration or if other radioactive elements existed in the remote past. The important question as to whether during geological time radioactivity has been a diminishing phenomenon may be answered by the halo. For the halo is, in fact, a sort of hieroglyphic, a writing in the rocks, which admits of interpretation based on to-day's experience of what radioactivity involves. All this is equally important to the geologist. For he wants to know, as vital to the past history of the surface changes of the earth, whether the known radioactive elements evolved thermal energy as they do to-day, or whether in the past notably more or notably less energy from this source affected the earth.

That halo-reversal is an actual and definite phenomenon seems certain. We cannot, indeed, be sure that it is quite similar in character to photographic reversal; but it acts much in the same manner and there is considerable probability that the two phenomena are very much the same in character.

The theory of photographic reversal may be stated in a few words. The action of light on the photographic plate is photo-electric in nature. Electrons are released from the silver halide each bearing a certain quantum of energy derived from the absorbed luminous vibratory energy. These electrons penetrate a certain distance from the illuminated point, which remains positively electrified, and create around it a negative electrostatic field. This ionised system constitutes the latent image. It may persist for months or years. If we apply a developer, the energy, potential in the latent image, is expended in promoting chemical interaction between the ionised silver halide and the developer. In this process the silver is liberated and is built up in the ionised region to form the visible image. Such is the typical course of events in the case of normal exposure.

Suppose, however, we prolong the exposure or use a very powerful source of illumination. The electrostatic field around the illuminated point grows stronger and stronger until finally the insulation breaks down. There is then re-combination of positive and negative ions and the plate is restored to its original state. At this stage development gives no visible image. The image has, in fact, been reversed, the former latent image having disappeared. This is the first

FIG. 4.—Uranium haloes in various stages of development. ×76. From Leinster Granite (Devonian).

reversal. If exposure be continued beyond the point of reversal, the original phenomena are repeated and a new latent image is formed like the first one, and so with continuous exposure the events in the film are repeated. The successive reversals may be demonstrated by exposing for increasing periods consecutive areas of a photographic plate.

The α-ray carries a certain quantum of energy according to its initial velocity when it leaves the transforming atom. The ray consists of a helium atom carrying two unit positive charges. In its passage through the mica it does work of ionisation. The original chemical bonding is disturbed, and under the influence of the ionisation, atomic systems are built up which are stable just as the latent image is stable. But it is conceivable that a second ray traversing the same or a nearly adjacent region may destroy this equilibrium and cause a reversion to the original equilibrium or to some new state of atomic equilibrium. The former case would result in the restoration of the original state of the mica: the latter may involve a new chemical bonding. As a matter of observation the new bonding appears, at least in some cases, to result in bleaching of the mica. Possibly successive "images" and reversals may occur. In experiments

on the age of haloes, Rutherford produced very intense coloration in biotite by exposing it to strong α-ray radiation. It might be possible to obtain some definite knowledge as to what actually happens by continuing such intense α-radiation for long intervals of time.

In the oldest rocks we certainly find plentiful evidence of bleaching around radioactive nuclei. If these particles happen to be sufficiently isolated, we get a

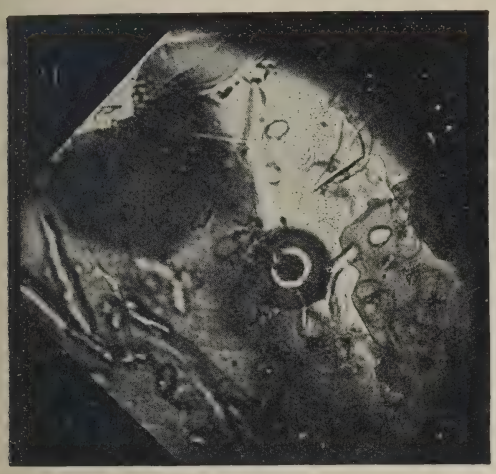

Fig. 5.—X-halo. ×256. Radius = 0·0294 mm. Ytterby mica. (Archæan.)

halo which may show some of its circular bands not as darkened areas but as colourless areas. If the particles are arranged in line and are sufficiently close together we get a bleached band, in the axis of which the particles are distributed. Outside the bleached band we see the effect of normal exposure in the darkening of the mica. Sometimes we find a halo very beautifully reversed or bleached where normally there would be successive dark rings.

In the study of haloes we have to bear other conditions in mind besides these changes brought about by reversal. Side by side in the oldest mica, embryonic haloes and "over-exposed" haloes are to be found, the former merely as a delicate ring of small radius surrounding a very minute nucleus, and the latter as a disc sometimes of almost impenetrable blackness (Fig. 4). Why is this? The answer is simple. The stage of development attained depends on two conditions: the age of the rock and the radioactive richness of the nucleus. These conditions correspond to duration of exposure and strength of illumination in the case of photography. Another obvious fact must also be borne in mind. The halo presented to us in the flake of mica may be a section off the centre of the halosphere, for serial sections of haloes in mica demonstrate that they are spherical. Rock sections revealing haloes contained in sections crossing the cleavage support this conclusion.

The phenomena attending bleaching have also to be held in view when studying these radiographs in very ancient rocks; for it may happen that certain outer or inner features may be obliterated thereby. In drawing the conclusion that a halo cannot be reconciled with known varieties, further evidence than the external dimensions of a few examples is required.

In the micas of Ytterby, which are of mid-Archæan age (pre-Huronian), I have found haloes which cannot be reconciled with haloes originating from known radioactive elements. These haloes I have called X-haloes (Fig. 5). There appear to be two varieties. I distinguish them as X_1- and X_2-haloes. They are fairly numerous. Sometimes, while free from any sign of bleaching, they look pale and washed-out. This is due possibly to some effect of over-exposure, just as an over-exposed plate lacks strength. Or, possibly, it is due to the remarkable metamorphic effects which this mica has generally experienced. In places such faded haloes may crowd together so as to overlap. They vary somewhat in dimensions, both externally and internally. But this effect may be due merely to different stages of development. Generally they consist of a central dark disc surrounded by two or three consecutive wide bands, the innermost one of which may be reversed. I do not think it is possible to ascribe X-haloes to thorium. Moreover, the thorium haloes which occur in this mica are always easily identifiable.

Here, then, is an example of the peculiar use we may make of these radiographs. If my conclusions are correct, we here find evidence either for an unknown element which has radioactively vanished off the earth, or for an undiscovered radioactive element.

In this same mica of Ytterby—but of extreme rarity—certain haloes of minute dimensions and all completely reversed or bleached also occur. I have called these "hibernium" haloes (Fig. 6). The majority are very uniform in dimensions, the radius being 0·0052 mm. A larger size—less abundant—seems present. These are closely 0·0086 mm. in radius. Now the earliest inner ring of a thorium halo is 0·011

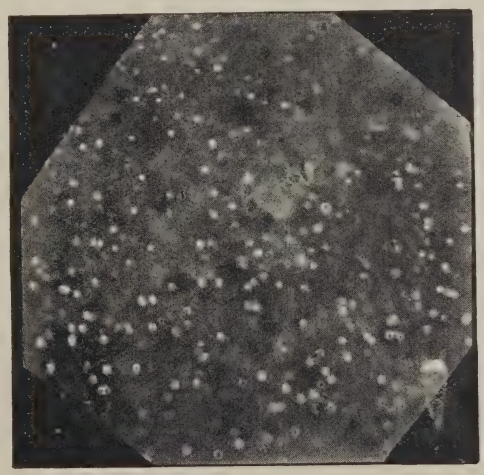

Fig. 6.—"Hibernium" haloes. Radii, 0·0052 mm. and 0·0086 mm. ×106·4. Ytterby mica. (Archæan.)

and of a uranium halo 0·014. If the conversion factor in this mica be taken as roughly 2000, the range in air of the rays responsible for the smaller hibernium halo would be a little more than 1 cm.

Each of these minute halospheres contains a nucleus accurately centred. If two such nuclei are sufficiently adjacent, the resulting halo is of the form of intersecting spheres. Three adjacent nuclei may give rise to a pear-shaped halo. There seems no doubt that their development is controlled by the nucleus in every case. As the bleaching is no objection to their radioactive origin, but in fact supports it, I see no alternative to the view that they are true haloes but of remarkably small dimensions. A prolonged search for other swarms of these haloes has proved unavailing.

It is of interest to notice that these haloes may be—not impossibly—generated by one of the known elements, for they must originate from a substance so feebly radioactive that no known method of observation would detect its radioactivity. This follows from the extremely small trajectory of the responsible α-rays. It will be remembered that Rutherford long ago pointed out that there existed a connexion between the initial velocity with which an α-ray was expelled and the period of the element giving rise to it. Geiger and Nuttall showed that a definite relation was deducible, most simply shown by plotting the logarithm of the constant of transformation against the logarithm of the range of the α-particle. Thus treated, the elements of each radioactive family are distributed approximately along a specific right line, and the lines for the uranium, thorium, and actinium series are sensibly parallel. From this investigation Geiger inferred that elements emitting α-particles of very small ranges would possess so slow a rate of transformation that no known instrumental method would reveal the fact that they were radioactive.

The age-long integration effected in the halo, however, can reveal radioactive phenomena far beyond the power of instrumental measurement. It is, therefore, not impossible that in these haloes we detect the radioactivity of some of those rare elements which this mica first revealed to science.

Lastly, one conspicuous fact is everywhere forced upon us in our studies of haloes—the scarcity of visible radioactivity in the rocks and the immense antiquity of that which we observe. In the absence of this mode of tracing radioactivity into the past, we might quite reasonably have argued that in former geological times many of the known elements were in process of radioactive genesis. The study of haloes rules out this view. Again, what radioactivity we are acquainted with has not originated in recent times. It dates back into the oldest rocks. The appearances which I have endeavoured to describe show this clearly. The reversed or blackened-up haloes of the Archæan are entirely different in appearance from those of Lower Palæozoic age. Indeed the geologist may by these appearances derive strong evidence as to the relative antiquity of the rocks he deals with. We arise from halo-study more than ever impressed with the immense age of the elements, and yet we know that some of them are to-day perishing off the earth and that a definite period is placed to their existence. What the halo ultimately shows is the remoteness of those past ages which probably witnessed the evolution of the elements.

The Malarial Treatment of General Paralysis.

FOR many years it has been realised that the intercurrence of an acute specific fever, such as erysipelas, in cases of general paralysis of the insane, is frequently followed by marked improvement in the general condition, and attempts have been made to procure remissions by the induction of an artificial pyrexia. In 1917, von Jauregg introduced the method of inoculation with malaria. About 5 c.c. of blood are taken from the vein of a patient suffering from benign tertian malaria and immediately injected subcutaneously, intravenously, or intramuscularly into the general paralytic. The average incubation period is about ten days, after which typical malarial attacks appear. When the patient has passed through ten or twelve attacks, the malaria is arrested by the administration of quinine and a course of neosalvarsan is given. Improvement is observed soon after the cure of the malaria, and in early cases of general paralysis the patient may become as capable as before the onset of the disease. Von Jauregg obtained prolonged remissions in more than fifty per cent. of his cases, the most noticeable features being the cessation of fits, better articulation, and general improvement in the mental and physical conditions. Other European observers have reported equally good results; in a series of 296 cases, Gerstmann found remissions in sixty-eight per cent.; Weigandt obtained improvement in forty-four out of fifty patients. In Great Britain the number of patients hitherto treated is small; Worster-Drought found improvement in all except one of twelve early cases; in a series of asylum patients, in whom the disease would be more advanced, improvement has been reported in six out of nine cases.

In dealing with syphilis of the central nervous system, the cerebro-spinal fluid affords an indicator of the inflammatory changes taking place in the brain and spinal cord, and the efficiency of treatment may be estimated by the resultant alterations in the fluid. So long as a positive Wassermann or any other abnormal reaction is given by the fluid, it cannot be considered that the disease has been eradicated. In cases of general paralysis, treatment by drugs has very little influence on these reactions; neither has it been found that inoculation with malaria, although producing remissions, has any effect in diminishing the intensity of the Wassermann and colloidal gold reactions. No patients have been observed for sufficient length of time to determine what period of improvement may be anticipated, but it must be remembered that spontaneous remissions are common during the course of general paralysis, and that relapses invariably follow. In view of the persistence in the cerebro-spinal fluid of the evidence of active syphilis, it cannot be expected that remissions following malarial inoculation will differ from those which arise spontaneously.

In our present state of knowledge, only speculation is possible concerning the mode of action of artificial pyrexia. Drugs, and probably specific antibodies, penetrate with great difficulty into the central nervous system; it may be that pyrexia with leucocytosis in some way increases the accessibility of the actual nervous tissue to the passage of substances from the blood-stream. Purves-Stewart suggests that the remissions are due to the destruction in the febrile reaction of some of the toxins affecting the cerebral cells, the specific organism of the disease being unaffected. He has published descriptions of two cases of general paralysis treated by malarial inoculation, followed by a course of intra-cisternal injections of salvarsanised serum. In the resulting remissions the cerebro-spinal fluid became completely normal in one case, and the pleocytosis was markedly diminished in the other. This result is of great importance in indicating that malarial inoculation, combined with a specific anti-syphilitic treatment which can reach the cerebral cortex, may prove to be a means of completely arresting the disease.

Inoculation with malaria is not entirely without drawbacks; there is a definite risk of the parasite being conveyed to other persons by the mosquito; the Board of Control has issued a letter to asylum superintendents recommending a number of precautions to be adopted against this risk. In advanced cases the attack of malaria may hasten the fatal termination, but, in view of the hopeless prognosis of general paralysis, this mortality cannot be considered as a contra-indication to a treatment which in early cases produces such marked remissions. The serious nature of the disease, and the complete failure of anti-syphilitic treatment to have any effect on its course, demand that every endeavour should be made to investigate and perfect a method which offers some hope of improvement.

Obituary.

Sir William A. Herdman, F.R.S.

THE sudden death of Sir William Abbot Herdman on July 21 will be deeply regretted by naturalists in many parts of the world. For several years his general health had been bad. His only son, George, was killed in the battle of the Somme, and this calamity accentuated an illness from rheumatism which left him partially crippled and with serious heart weakness. He had begun to shake off the rheumatism when his wife died after two days' illness from pneumonia, and since then his health continued to be bad. He had gone to London on the day that he died to be present at the wedding of his daughter, and had arranged to leave Liverpool three days later for the British Association Meeting at Toronto.

Herdman was born at Edinburgh in 1858, and was educated at the High School and University in that city. He graduated in science in 1879, and was for a short time assistant to Sir Wyville Thomson. Then he went to the *Challenger* office, where he worked under Sir John Murray, and began the description of the Tunicate collections, a work which he finished at Liverpool. He went to the latter city in 1881, when the University College was established, as the Derby professor of natural history. In 1919 he retired from his chair (then that of zoology), and became professor of oceanography, a post which he held for a year, when he retired as Emeritus Professor. His connexion with the University of Liverpool did not, however, cease in 1921: he was a member of council and of various committees, and during the Lent term of 1924 he was acting vice-chancellor in the absence, on sick leave, of Dr. Adami. He had a room in the Department of Zoology, and he was there almost daily. At the time of his death he was engaged in a research on the morphology of Ramulina.

During the latter part of his life Herdman was a comparatively wealthy man, and (with his wife) was a generous donor to the University. He endowed the chair of geology in 1916, and that of oceanography in 1919. In 1923 he gave the University a sum of 20,000*l.* to assist in the building of a new department of geology. He endowed an exhibition, and he bought and furnished a building at Port Erin as an institute and club for fishermen. For the last dozen years of his life he had become greatly attached to Port Erin, where he owned a house at which he resided during a considerable part of each year. His interest in Manx affairs was strong, and he was practically responsible for the foundation of the new Government Museum at Douglas.

Herdman's life-work was, of course, marine biology: that he began by a series of dredging expeditions in the Firth of Forth; developed in the *Challenger* office, and continued when he went to Liverpool. There he found a small group of amateur naturalists whom he organised as the Liverpool Marine Biology Committee; he outlived nearly all these original workers. They prosecuted active, systematic, biological investigations in the Irish Sea region, at first hiring steam tugs for their dredging and trawling expeditions. Then they fitted out a biological station at Puffin Island, in Anglesey, and later built two stations at Port Erin, in the Isle of Man. In 1892 Herdman organised the scientific work of the Lancashire Sea Fisheries Committee, and persuaded the latter body to found the Fisheries Laboratories at the University of Liverpool, and at Piel in Barrow. The result of these activities has been a very satisfactory biological survey of the Irish Sea, summarised in five volumes of a "Fauna and Flora," and a long series of papers on fishery subjects written by Herdman and his colleagues, and published by the Fisheries Committee. This work was, at first, financed locally, but, later, it was supported by government grants with results that have not been satisfactory. The local contributions have tended to decrease; there has been an unnecessary control over expenditure, and an insecurity of tenure of post for the scientific men employed.

In 1901–2 Herdman went to Ceylon for the greater part of a year, at the request of the Colonial Office, to study the pearl-oyster fisheries. He went out again

a year or two later at the request of the syndicate of pearl fishers, which had in the meantime leased the fishery rights from the Government. The results of these expeditions was a very complete biological survey of the pearl banks, published in five volumes by the Royal Society, and an hypothesis of pearl formation which has given rise to much controversy. He was, in 1892, elected a fellow of the Royal Society, and was its foreign secretary in 1916–20. He was president of the Linnean Society in 1904, president of Section D of the British Association in 1895, and president of the Association at the Cardiff meeting in 1920. During the war years he was chairman of the Grain Pests (War) Committee of the Royal Society. He was a member of various official commissions and advisory committees, and gave expert testimony before other similar bodies. He received many honours during his lifetime: he was a D.Sc. and LL.D. of the University of Edinburgh, and a D.Sc. of the Universities of Harvard, Durham, Sydney, and West Australia. He was made a C.B.E. in 1920, and was knighted in 1922.

Herdman was, above all, a field naturalist and systematist of the type which seems now to be passing away. His knowledge of species of animals was extraordinarily good: helpful (and at times embarrassing) to his colleagues and assistants. This fine zoological knowledge was of immense value to him in his fishery investigations. He was adventurous, very active, and inclined to "rough it" until middle age: he and his friend Isaac Thompson for a time went regularly to Port Erin Bay to swim during the Christmas vacations. He was a keen traveller and yachtsman, and had visited most countries in the world. For many years he owned small steam vessels which he worked himself up the west coast of Scotland, round St. Kilda, and through the Orkneys and Shetlands on his trawling and plankton expeditions. He always had strong interest in archæological investigation, and with his friend P. C. Kermode did a good deal of excavation in the Isle of Man, while at one time or another he had visited most of the places of anthropological interest in the continent of Europe. In his own home he was at his best: an accomplished talker, most hospitable and good-humoured. On his fiftieth birthday his family presented him with a pipe, and after that he became an inveterate smoker. While his interests were thus very wide, he was first and last a marine biologist, both as an investigator and an expositor, and it is in this direction that his influence was most widely manifested, and will be most sadly missed.

J. J.

MR. EDWIN THOMPSON, who was one of the local honorary secretaries for the Liverpool meeting of the British Association last year, sends the following tribute:

Sir William Herdman was known throughout the world as a great oceanographer. There are thousands who, in addition, knew him as a delightful personality, and there are others who had the privilege of knowing him as the kindest, most cheery, most breezy and sympathetic of men. To have known Sir William Herdman personally was an education in the highest sense of the word; he knew and could teach others how to work and how to play, but he never knew what it was to waste time. The short memoir he wrote about his son, George, who was killed in the War, was, I think, an inspiration to every boy who read it, and I always wished that it had been made public, and I feel that Sir William Herdman's life, if it is ever written, will be an inspiration to every man whether he be interested in science or not.

When Sir William Herdman took a holiday it was to work, and I have had the pleasure of seeing him at sea working with the late Sir John Murray, Haeckel, and others, and also years ago have seen him organise children's parties with an understanding with which one does not usually credit great men of science; he might, in fact, have been the author of "Peter Pan." No man was ever made to feel a fool by Herdman, and it is only a great man who has that attribute. It needs a man with a big brain to lecture on scientific subjects to a large audience in such a manner that the subject is clear to every one, even the least intelligent. Sir William Herdman had this power in an extraordinary degree.

His last years were full of sorrow, but with his characteristic pluck he never let others see the sadness in his heart. The strain had told upon him, however, and he knew every time he went upstairs that he might not reach the top alive, but he did not let that interfere with his work or the pleasure he gave to others.

He died suddenly as he would have wished, without a long illness, which to him would have been a terrible trial. His friends, Liverpool, and the whole world have lost a great man, and those who knew him intimately can to a small extent realise the sadness felt by his three daughters and their pride in having such a father. I would just like to tell how he died, as there were many garbled reports, which gave rise to misunderstandings. He travelled to London on Monday, July 21, and gave a little family dinner on the eve of his daughter's wedding. Before going to bed he went out for a short stroll, as was a very frequent custom of his, and in the street he had a heart attack. Fortunately, a woman was passing at the time, and seeing him in distress helped him into the nearest house, which was a small hotel; but by the time the doctor had arrived he was dead. The doctor then sent for the police, who identified him by papers in his pockets. It is tragic that his family were not with him; but it is far more tragic that the false reports should have caused any misunderstanding or been misinterpreted by those who did not know him.

WE regret to announce the following deaths:

Miss K. A. Burke, assistant lecturer in chemistry at University College, London.

Prof. Heinrich Precht, who was closely associated with the German potash industry and contributed many important investigations in this field, aged seventy-two.

Prof. James Seth, professor of moral philosophy in the University of Edinburgh from 1898 until a few weeks ago, on July 24, at sixty-four years of age.

Current Topics and Events.

RECENT criticism of the British Museum Bill fully justifies the comments in our issue for July 5. Sir Hercules Read, as an ex-officer and former trustee of the Museum, in a letter to the *Times* of July 26, emphasises the point that the objects in the national collection are not duplicates, and that the temporary removal of any specimens other than those of trifling interest would disorganise the exhibition and study series, and would add to the difficulties of the serious investigator. The Trustees, who did not ask for this Bill, would in most cases escape from a difficult or delicate position by exercising their discretionary veto. On the other hand, the provincial museums object to the Bill on two grounds: the categories of permissible loans are not those which they particularly desire, and the conditions imposed are onerous if not impossible. The Museums Association has therefore passed a resolution of protest, and has once more called for a Royal Commission to inquire into the whole question of the national organisation of museums. The resolution, which has been sent to the Prime Minister, is as follows: "This Association regrets that the British Museums Bill No. 2, promoted in the interests of provincial museums, should have been introduced without consulting the body which represents those museums and knows their needs, and expresses a hope that the Prime Minister will be so good as to receive a deputation from the Museums Association, which would explain the urgent necessity for the appointment of a Royal Commission to inquire into the work of all the museums of this country."

THE continued closing of the Museum of Practical Geology, London, was discussed at the meeting of the Museums Association last week, and a resolution upon the subject was passed, to be forwarded to the President of the Board of Education. A question asked in the House of Commons on Monday by Major Church, secretary of the National Union of Scientific Workers, elicited some interesting information on the matter. The question was: "To ask the First Commissioner of Works if he can state how long the Geological Museum will be closed for repairs, in view of the importance of the museum to the nation; and will he state why the structural alterations and repairs now being undertaken were not commenced before." In reply, Mr. Jowett, First Commissioner of Works, said: "It has now been decided to proceed with the erection of a new building at South Kensington to house the offices of the Geological Survey and the Museum of Practical Geology, and a Supplementary Estimate for the provision of funds for this purpose is being presented to the House at an early date. The repairs required to the present building to enable it to be reopened to the public are not being proceeded with, but the administrative work of the Geological Survey will still be carried on, and the public will have access to the Library and Map Room. As regards the last part of the question, the execution of the structural alterations and repairs was suspended pending a decision as to the future of the Museum."

THE annual meeting of the Imperial Cancer Research Fund was held on July 23, when the twenty-second annual report was presented and adopted. The report discloses satisfactory steady progress. The finances are sound, though half the annual income comes from subscriptions and donations. The new laboratory at Mill Hill, adjoining the farm of the Medical Research Council and due to the beneficence of the executors of the late A. C. Stroud, has been erected, and the laboratories at Queen Square continue to make the sound contributions to our knowledge of the biology of cancer which has always characterised their activities. After prolonged discussion the Fund has found a means of co-operating with the British Empire Cancer Campaign through the appointment by the Royal Society and Medical Research Council of an advisory committee which will advise the Campaign on the allocation of funds for investigation. The Middlesex Hospital, the Cancer Hospital, and the Fund have also nominated representatives on the grand council of the Campaign. It is hoped that by this arrangement the newest organisation for the investigation of cancer may have the advantage of the experience gained through many years by the older bodies.

ACTIVITY in the experimental investigation of cancer has recently centred largely around the relation between certain forms of long-continued skin irritation—notably by tar—and the development of malignant tumours. One of the most noteworthy contributions to the same topic, but from the observational side, is contributed by Dr. Alexander Scott, of Broxburn, who has practised for many years among the operatives in the Scottish shale oil works, to the eighth scientific report of the Imperial Cancer Research Fund. We have here a singularly exhaustive study of the inflammatory conditions of the skin brought about by the repeated irritation of crude paraffins and the conditions under which cancer develops in the affected areas of skin. Dr. Scott's observations, which are illustrated by a large number of illustrative photographs, are particularly valuable, because they comprise the history of nearly twenty-five years—a continuity much needed and so often lacking in clinical studies. They bring out clearly the close parallelism between paraffin cancer in man and experimental tar cancer in mice, especially in respect of the length of the prodromal stages and the course of the disease after tumour growth has started. As a result of his work, preventive measures have been installed in the industry: fresh cancers will no doubt develop for some time, as they do in mice, as the result of past irritation, but in the end his pictures will—or ought to—become a unique historical record of something which no longer exists.

"EDUCATIONAL HARMONICS" is the phrase in which the *Times* sums up the character of the debate in the House of Commons on July 22 on the education estimates. With one or two exceptions, the speakers made no attempts to use the debate as an opportunity

for scoring points for their respective parties. There was general agreement that the problem of adolescent education is of paramount importance, and Mr. Fisher and Mr. Wood were to that extent at one with Mr. Trevelyan in his proposal that for the next few years extraordinary efforts should be made, whatever political party may be in power, to provide for a great increase in the number of secondary school pupils. Mr. Trevelyan suggested that their number, which is already double what it was only a few years ago, should be again doubled within the next ten years. He is less sanguine than Mr. Fisher as to the potentialities of day continuation schools, and laid less stress than Mr. Wood on the importance of central schools, but is willing to support local efforts to develop either. There was no discussion of educational aims, and no revival of the proposal made two years ago for a commission of inquiry into the subject; yet, as Mr. Wood remarked, the mere expenditure of much money will never be enough unless the system be right, and unless we know where we are going and what we want to get out of it. Mr. Trevelyan's assumption that "there could be no difference in the main objective in education of succeeding governments" may be convenient for preserving harmony in parliamentary debates, but there is little else in its favour. An authoritative statement on the subject commanding general respect would do more to promote real efficiency than the expenditure of many millions, and is doubly desirable in view of the anticipated great expansion of secondary education.

MR. HOOVER, the Secretary of Commerce, U.S.A., in addressing the Izaak Walton League at Chicago in April last, spoke of the attitude that a good government ought to observe in its consideration of fishery problems. Thousands of generations of free fishermen have established their tradition to catch unlimited fish, but now this tradition encounters the spirit of modern industry. There is over-fishing and depletion, so that already the systematised fishing trade, with the "demonic assistance of the tin can," is rapidly destroying the Pacific salmon rivers. Long ago, villages situated on rivers and seashores established a right to deposit their waste products on the nearest stream or foreshore. Little harm was done originally, but now the modern factory, the great city with its sewerage system and the new oil-driven vessel, are rapidly making tidal rivers and shores incredibly foul, so that another ancient privilege has become incompatible with a fishing industry that seeks to develop as others have done. Finally, the conflict between federal government and local autonomy (as represented by the American States, or the provincial systems of regulation in Great Britain) has, so far, led to confusion of policy and waste of effort. To these problems, Mr. Hoover asks the fishery administrators to bring the contemplative mind, the faith and optimism, and the patience and reserve that come to the followers of Izaak Walton; and, one may add, without any suspicion of cynicism, he asks in vain, for the qualities he postulates do not seem to come to those who look at fishery questions through official windows.

THE leading part taken by Messrs. Chance Bros. and Co., Ltd., in the development of optical glass manufacture and their successful efforts during the War to meet the enormously increased demands are well known. These, however, form only a small part of this firm's contribution to the development of glass manufacture during the last hundred years. In 1824 Robert Lucas Chance purchased the works of the British Crown-Glass Company at Smethwick, and thus provided the nucleus round which the modern works of Messrs. Chance have grown. Ever since then, the name of Chance has been intimately associated with the history of glass making in Britain. The firm's first achievement of outstanding importance was the introduction into England, in 1832, of the manufacture of sheet glass. This was soon followed by the production of rolled plate and later of "figured rolled" glass. In 1840 the firm inaugurated the manufacture of thin glass for microscope cover-glasses, which greatly extended the possibilities of accurate microscope work. For many years Messrs. Chance have provided a large proportion of the world's supply of glass for spectacles, while recent developments include the production of heat-resisting glasses for illuminating ware and of chemical resistance glass for laboratory ware. An interesting record of the firm's activities and achievements is contained in an illustrated pamphlet, "100 Years of British Glass Making, 1824–1924," which has recently been issued by the firm to commemorate its centenary celebrations.

THE building of the Literary and Scientific Institution of Bath was opened in January 1825. During the past hundred years much good work, especially in geology, has proceeded from Bath, as the names of William Smith, Lonsdale, Charles Moore, and H. H. Winwood bear witness; and the museum of the Institution houses many specimens of scientific importance, notably the fossils of the Charles Moore collection. Unfortunately the good people of Bath did not keep up their interest in the side of life represented by the Institution, and of late years, particularly during the War, the building was falling into decay, not without danger to its contents. Now there seems to be an intellectual and material revival. Repairs and rearrangements have been effected by the zeal and generosity of a few, and in one year 9000 visitors have passed through the pillared entrance. But more needs to be done if the Institution is to have a home worthy of its traditions and of its beautiful city. It is proposed to celebrate the centenary next January, and the most appropriate form of celebration will be a pecuniary contribution forwarded to the Secretary, Mr. P. E. Martineau. We cordially commend the appeal to our readers, who will be the more ready to help those who are helping themselves.

THE fourth Annual Report of the Forestry Commissioners for the year ending September 30, 1923, shows steady progress in afforestation. During the year, 10,463 acres were planted with about 18,000,000 trees, mostly conifers, the species used being Scots and Corsican pines, Norway and Sitka spruces, European

nd Japanese larches, and Douglas fir. The cost of planting averaged 7*l.* per acre; and this figure included preparation of the ground, draining, fencing, ctual planting, filling in blanks, and weeding. Except or seed, tools, and wire, the whole of this expenditure was on wages. The total land acquired during the our years amounts to 179,207 acres, of which 121,015 cres are classified as plantable, the remainder being ither too poor or too good for timber production. n addition, eighteen Crown woods, formerly under the Commissioners of Woods and totalling 120,000 acres, vere transferred in 1923 by Act of Parliament to the Forestry Commissioners. Two maps in the Report how the situation of all the areas now under the control of the latter. There are now two schools for he training of woodmen, one at Parkend in the Forest of Dean, and the other at Beaufort in Inverness-shire. Research and experimental work has made good progress. As many as 143 experimental plots, which are regularly thinned and measured, have been established in different parts of England and Scotland. A census of British woodlands is in course of preparation, and a summary of the completed statistics for twelve counties is given in the Report. The Forestry Commissioners were represented at the British Empire Forestry Conference, which was held in Canada during the summer of 1923; and a full account of the important resolutions passed by the Conference is appended to the Report.

"METEOROLOGY in Education" is the title of the reprint, now published, of the papers read on January 3 last at a conference of the Royal Meteorological Society, the Geographical Association, and the Science Masters' Association (Messrs. George Philip and Son, Ltd. 6*d.* net). Sir Napier Shaw, who presided, introduced the subject as the study of weather as a scientific subject, and Mr. J. Fairgrieve in the course of the discussion claimed that the conference was a successful attempt to get geography teachers and meteorologists to talk to each other. Mr. G. M. B. Dobson contributed a paper detailing recent results of research especially in regard to cyclonic and monsoon rains. Mr. L. B. Cundall in a paper dealing with school work in meteorology pleaded for the creation of a joint advisory committee of the three bodies to decide what should be taught in this connexion, and Mr. W. G. W. Mitchell directed attention to the use of wireless in relation to the compilation in schools of synoptic weather charts. During the discussion Sir Richard Gregory and Mr. W. E. Whitehouse both emphasised the position of the teacher of geography, for whom the results of meteorological science were merely initial data for use in the class-room. Dr. G. C. Simpson advised teachers to teach meteorology because it is a body of knowledge to which the pupil should be introduced. In any event the conference made quite clear that the current geographical teaching concerning rainfall distribution in relation to winds and pressure variation requires considerable emendation. Sir Napier Shaw stated that the wind distribution was only known for about three-fifths of the earth's surface.

THE library of the Chemical Society will be closed for stock-taking on August 4-August 16 inclusive, and will close each evening at 5 o'clock from August 18 until September 13.

DR. R. E. M. WHEELER, Keeper of the Department of Archæology in the National Museum of Wales and lecturer in archæology in the University College of South Wales and Monmouthshire at Cardiff, has been appointed Director of the National Museum of Wales, in succession to Dr. W. E. Hoyle, who has resigned owing to ill-health.

IN agreement with the programme of the International Commission for the Upper Air, the Meteorological Office of the Air Ministry sent up twelve registering balloons between March 3 and 22. The *Meteorological Magazine* for July states that of these, nine instruments have been found and returned. Eight ascents were made from the aerodrome at Shotwick, near Chester, and four from Kew Observatory, the losses being respectively 2 and 1. The greatest height reached was 19·3 km., 12 miles, the drifts being towards points between north-north-east and south-east. During five months working, 80 per cent. of the balloons sent up have been found and returned.

A DANISH ship, the *Godthaab*, started from Thorshavn at the end of June, according to the *Meteorological Magazine* for July, to visit settlements in north-east Greenland. The vessel is to keep in communication with Jan Mayen by wireless telegraphy, and meteorological reports are being transmitted via Tromsoe. Reports from the *Godthaab* in the area off north-east Greenland in about latitude 75° N. have been received by the Forecast Division of the Meteorological Office, and they extend the information of the daily weather charts into the region of the Arctic north of the island of Jan Mayen and south-west of Spitsbergen, from both of which places daily reports are regularly received.

UNDER the auspices of the Royal Society for the Protection of Birds, a bird sanctuary has been established near Farnham, in Surrey, consisting of some twenty-seven acres of wild gorse, heather, and woodland, and well watered. This is eventually to become the property of the Royal Society for the Protection of Birds, so that it may be obtained in perpetuity as a wild nature reserve. A watcher who is well versed in wood-craft and bird-lore has been appointed, and an earnest appeal is made for the sum of 500*l.* to provide him with a cottage so that he can continually be on the estate. Donations will be gladly received by the hon. sec., R.S.P.B., 82 Victoria Street, London, S.W., or by Mrs. Minchin, Gorsedene, Farnham, Surrey.

THE marine biological laboratory at Wood's Hole in Massachusetts, founded in 1888 and for many years a centre of attraction to biologists of all parts of America, is to be developed on a great scale by means of a gift of 1,400,000 dollars from the Rockefeller Foundation, the Carnegie Corporation, and a fund endowed by Mr. C. R. Crane of Chicago. A combined laboratory and library building is to be

constructed at once at a cost of 600,000 dollars. At Wood's Hole, which has been called the summer capitol of American biology, zoologists, physiologists, embryologists and botanists gather every summer both for independent research and for theoretical and practical instruction courses. During 1923, seventy universities and research organisations contributed to the support of the laboratory.

By virtue of the Importation of Plumage (No. 2) Order, 1922, and (No. 1) Order, 1923, respectively, the names of the golden pheasant and of the *common or mute swan* were added to the Schedule to the Importation of Plumage Prohibition Act, 1921, which contains the names of certain birds whose plumage may be imported without licence. The Advisory Committee appointed under the Act has now recommended that the common or mute swan should be removed from the Schedule, but that the golden pheasant should remain thereon. The Board of Trade accordingly desires it to be known that an Order will be made in due course removing the name of the *common or mute swan* from the Schedule, with effect from October 1, 1924. On and after that date, the plumage of this bird will accordingly be prohibited from being imported except under Board of Trade licence issued in accordance with the provisions of the Act. The right to import the plumage of the golden pheasant without licence will continue as heretofore.

Dr. N. H. Darton, geologist, has left Washington to join the National Geographic Society's expedition, which is exploring an ancient temple in the Valley of Mexico, the oldest ruins so far discovered in the Americas. Dr. Darton will study especially the sequence of geological events, including the lava flows and the recession of Lake Texcoco, with the view of determining more nearly the exact period of the civilisation which flourished on the American continent some 7000 years ago. Mr. Byron Cummings, the head of the expedition, has already reported remarkable finds among the lava-encased temple mound—finds ranging from pottery, images, and sculpture to parts of human skeletons. It is believed the mound was built on or near the shore of Lake Texcoco originally, but the water line of the lake is now twelve miles distant. The lake had receded a considerable distance when a sudden volcanic eruption half buried the temple mound, which still was inhabited.

A conference on Illuminating Engineering has been arranged to take place at the British Empire Exhibition on Tuesday, August 12 (2.30-5.30 p.m.). The conference is timely in view of the two important conferences just held in Geneva, namely the first International Conference on Industrial Hygiene, and the meeting of the International Illumination Commission. In both cases important papers dealing with illumination were read, and special attention was devoted to the lighting of schools and factories. A report on the proceedings at these two congresses is to be presented, and other papers dealing with public lighting and other subjects will be read. It is also interesting to note that the opportunity will be taken at this conference to discuss the question of the lighting of exhibitions. Fuller particulars of the conference will be obtainable in due course from the hon. secretary of the Illuminating Engineering Society (Mr. L. Gaster, 32 Victoria Street, London, S.W.1).

Our Astronomical Column.

Spiral and Structureless Nebulæ.—The *Observatory* for July contains a letter on this subject by Prof. C. D. Perrine. He criticises Prof. Lindemann's suggestion that the spirals are dust-clouds shining by reflection from the galaxy; he notes in opposition to this view that the Coal Sack and other very dark regions appear to be dust-clouds absorbing the light of the stars behind them; we should therefore expect them to shine by reflection much more brightly than the spirals since they are presumably much closer to the galactic stars; nevertheless they appear quite non-luminous both to the eye and photographic plate while the Andromeda nebula is very luminous. Further, he dwells on differences in the spectra of different spirals, some showing bright lines, others not; these would be difficult to understand if all of them shone by reflected galactic light.

Prof. Perrine considers that the structureless nebulæ are related to the spirals, being at an earlier stage of condensation, with less rapid rotation; both alike are supposed to consist of "cosmical matter." Possibly a considerable part of this may attain incandescence through collisions or electrical excitation, sufficient gas being evolved to account for the absorption spectra.

The variety of opinion that prevails about the nature of the spirals is evidence of the difficulty of the problems that they present. It is well to consider all reasonable suggestions, but not to expect a definite or final solution in the near future.

The Planet Uranus.—Mr. W. F. Denning writes that Uranus will be favourably visible during the ensuing few months. The planet will rise on August 1 at 9 h. 6 m. p.m. and on August 31 at 7·6 p.m. G.M.T. It will be in opposition to the sun on September 12 and will be perceptible during the whole night. Its position is in the southern portion of Pisces, and its present motion is retrograde amongst the small stars in that region. The planet's place may be found from an ephemeris and by the help of a catalogue of small stars. The intending observer should make a diagram containing the places of Uranus and of the stars in the same locality and then examine the sky with a suitable telescope and low power. In this way the planet may be easily identified; but should this method fail, the object may be known by its disc, which will be apparent with very moderate power and will contrast strongly with stellar images in the same field of view. The planet is distinctly visible to the unaided eye, being about 5½ magnitude, and Mr. Denning considers, from many observations made at Bristol, that it might quite possibly have been discovered without telescopic aid, as it has been watched on many clear evenings near opposition in past years and changes distinctly noticed in its position. Uranus and the Moon will make some near approaches during ensuing months:

1924.	G.M.T. h.	m.				
Aug. 16	9	16	Uranus	1°	44′	north of Moon.
Sept. 12	16	38	,,	1	37	,, ,,
Oct. 9	22	17	,,	1	34	,, ,,
Nov. 6	2	43	,,	1	42	,, ,,

Research Items.

Witchcraft in Medieval India.—Mr. W. Ivanow directs attention in the Journal of the Asiatic Society of Bengal, vol. xix., New Series, No. 3, to a "witch case" which affords a remarkably close parallel in its details to the practices of European witches. Hamid b. Fadli'l-lah Jamāli (a Sufi of Northern India) records about A.D. 1530, in a collection of stories of miraculous deeds, that when Shaykhu'l-Islām Farīdu'd-Dīn Mas'ud (d. A.D. 1265) was suffering from a serious indisposition, it was revealed to his son in a dream that he had been bewitched, but that the spell could be removed by the repetition of certain incantations over the tomb of a sorcerer, the father of the man responsible for the Shaykh's illness. These instructions were followed, and in the course of repeating the incantations the son of the Shaykh accidentally discovered, hidden in the grave, a figure made of flour into which some needles were stuck, and on which were knotted hairs from a horse's tail. The figure was taken to the Shaykh, who ordered the needles to be drawn out, and the hairs to be unknotted. As this was done the pain diminished, and when all the needles had been withdrawn and all the hairs untied, it disappeared. The sorcerer was apprehended, but—and here the parallel with Europe ceases—was pardoned.

Racial Intrusions in Ancient Egypt.—Sir Flinders Petrie in *Ancient Egypt* for June discusses the origin of the XIIth Dynasty in the light of the results obtained by the British School of Archæology in the excavations at Qau. Up to last season, it was known that there had been a Syrian occupation of Northern Egypt, a Libyan occupation of Middle Egypt, and, there was strong presumption, a Galla intrusion which could have originated this Dynasty. The examination of the tombs of the Uahka family at Qau last winter and a study of their names at different periods point to the existence of a principate holding Upper Egypt about the IXth and Xth Dynasties which brought in tombs of a hitherto unknown Nubian type. The measurements of the skulls indicate a close connexion between the Tigre skulls and Middle Dynastic Egyptian types, thus according with the Galla portrait in pointing to a southern origin. It would appear that when in the VIth Dynasty the Syrians took over the kingdom from the Egyptians, a king of the old style remained in the south, holding Nubia and Koptos. He was succeeded by invaders akin to the modern Gallas who held the Thebaid under the Libyan invaders and built the great temple-tombs of Qau. The Qau princes lasted through the Xth Dynasty, and finally one of them, aspiring to hold Thebes, took the name Amenemhat, and at the end of the Antef and Mentuhetep families occupied the throne and founded the line of the XIIth Dynasty, which, to the end, kept the features of its ancestry.

Mosquito Control at Hayling Island.—The third annual report of the Hayling Mosquito Control announces that satisfactory progress has been made in dealing with the local mosquito nuisance, although unavoidable delays have prevented the completion of the important experiments which had been undertaken on the range of flight of the salt-marsh species. The Control has, however, succeeded in obtaining the co-operation of a large number of persons by whose help it is hoped to make a detailed survey of the mosquitoes of south-east England. Such a survey should yield valuable results in elucidating the factors limiting the distribution of the various species as well as the individual range of flight. The year's work confirms the conclusion that the main pest in low-lying areas of the south coast is *Ochlerotatus detritus*. The present report is illustrated by some very fine photographs of this species, taken from a series of illustrations of the British mosquitoes which is being prepared by Mr. J. F. Marshall, the director of the Control, in his laboratory at "Seacourt," Hayling Island, Hants.

A New Crustacean.—The discovery of a representative of a new order in any group of animals is an event of interest to others besides the mere systematic specialist. This may perhaps prove to be the significance of the minute Crustacean which Th. Monod describes under the name of *Thermosbæna mirabilis* (Bull. Soc. Zool. France, xlix. No. 2, 1924, pp. 58-68). It was found at El Hamma in Algeria in a Roman bath-cistern fed by a hot spring at a temperature of 48° C. The animal is about 3 mm. in length, colourless, and without any trace of eyes, its proper habitat being doubtless in the subterranean reservoirs from which the spring takes its origin. Its general appearance is that of a small Isopod, but the fore part of the body, as far as the fourth thoracic somite, is covered by a reduced carapace, the antennules are biramous, and the five pairs of walking legs (the last two pairs are suppressed) carry large exopodites. Pleopods are absent except the first and second pairs, which are vestigial. The telson is coalesced with the last somite and the uropods are peculiar, with the inner branch much reduced. The mandibles are of the typical Peracaridan structure, and the other mouth-parts, although there are difficulties in their interpretation, are probably to be referred to the Mysidacean type. No breeding specimens were found, and it remains to be seen whether the individuals described had assumed fully adult characters and, in particular, whether the female possesses a brood-pouch of the characteristic Peracaridan structure. In many of its features, Thermosbæna shows that simplification of structure which often goes with reduction in size and a subterranean habitat. When allowance is made for this, however, it seems to form a very satisfactory link between the Mysidacea and the Tanaidacea. There are few, if any, groups of arthropods in which it is possible, on morphological grounds alone, to construct so reasonably probable a phylogenetic series as that which leads from the Mysidacea through the Tanaidacea to the Isopoda. In this series there is a place ready for Thermosbæna, either as an outlying member of one of the existing orders or, more probably, as the solitary representative of a new order to be established for its reception when we have fuller knowledge of its structure.

Amœba Feeding on Frontonia.—C. Dalé Beers (*Brit. Journ. Exp. Biol.*, vol. 1, pp. 335-341, 1924) records observations on the feeding of *Amœba proteus* on the ciliate Frontonia. An Amœba was observed to have partially engulfed a Frontonia and by its pressure to have constricted the middle region of the ciliate until the latter was forced into the form of a dumb-bell, not by the pressure of two opposed pseudopodia, but by that exerted by a collar of the Amœba's protoplasm. One half of the Frontonia was enclosed by the Amœba, the other half was exposed, and by the beating of its cilia dragged the Amœba. Later the Amœba attached itself to the microscopic slide and proceeded with the ingestion, extending its protoplasmic collar while still maintaining the pressure exerted by it upon the narrow middle portion of the ciliate, so that this portion became continuously longer and finally gave way. The part of the ciliate within the Amœba was soon enclosed in a large food

vacuole—the whole process from beginning to end occupying eight minutes. Digestion of the engulfed part lasted nearly four days. In another case observed, the Amœba carried out the same process, the pseudopodial collar being composed apparently only of ectosarc. The author points out that the observations do not accord with the view that the varied activities of Amœba are brought about entirely by changes in the surface tension of the protoplasm; it appears impossible to believe that surface tension could account for the compression of so turgid an organism as Frontonia, and for other features in the process of ingestion.

Culture of an Endamœba from the Turtle.—H. P. Barret and Nannie M. Smith (*Amer. Journ. Hygiene*, vol. iv., pp. 155-159, 1924) give an account of the cultivation of an Endamœba from the turtle *Chelydra serpentina*. The medium employed was human blood serum one part with nine parts of 0·5 per cent. salt solution. A portion of mucus containing the amœbæ from the intestine of the turtle was placed at the bottom of the culture tube in which the medium formed a column about 50 mm. deep, and the tubes were kept at room temperature or in a cool chest (10°-15° C.). The presence of numerous bacteria or of blastocystis is inimical. The growth of the amœbæ takes place only at the bottom of the tube, never in the supernatant medium. On microscopic examination numerous dividing forms were observed, but no cysts were found even in old cultures. At the time of writing (October 1923) one strain was in its sixty-seventh subculture and had been carried on for 19 months, and two others had been grown 11 months and were each in the 36th subculture. It is pointed out that this material offers an easier problem than the human Endamœbæ as the lower temperature of the culture retards excessive bacterial growth. The authors remark that Cutler is the only recent worker who has succeeded in obtaining cultures of parasitic amœbæ, and though his work has been criticised by Dobell they "cannot fail to give credit to Cutler as being the first to grow parasitic amœbæ from the human intestine." In a paper which immediately follows, W. H. Taliaferro and F. O. Holmes describe specimens of the amœba—*Endamœba barreti*—from the turtle and from the cultures.

Utilisation of Seaweed.—The Fuel Research Board of the Department of Scientific and Industrial Research has issued a Technical Paper (No. 9) dealing with the carbonisation of seaweed as a preliminary to the extraction of iodine and potassium salts. This industry has long been worked in the British Isles, and the weed has also been used as a manure. The old method of kelp-burning is very inefficient, and the work of Stanford, carried out in 1870–90, pointed the way to improved methods. The paper describes further investigations along similar lines, and an endeavour has been made to provide data which will be useful in devising a method of carbonisation of the weed in which there would be no loss of iodine and in which the gaseous products could be used for firing the retorts. A detailed description of the types of weed utilised, principally Laminaria, which contains about 0·5 per cent. of iodine, and of experiments on carbonisation, carried out on a small manufacturing scale, is given. During the nineteenth century the industry provided not a little employment, especially in the west of Scotland and in Ireland, and the report is worthy of attention.

Scarcity of Tertiary Crinoids.—In describing a new species of Balanocrinus from the Lower Miocene of Haiti (Proc. U.S. Nat. Mus., No. 2516), Dr. Frank Springer points out that this is the first stalked crinoid of Tertiary age to be described from the western hemisphere, and takes occasion to comment on the rarity of Tertiary crinoids in general. Although the number of crinoid species living to-day is probably as great as the number existing at any one time during the previous history of the earth, still the majority occur in relatively deep waters. Most Tertiary rocks are shallow-water deposits, and the inference is that crinoids assumed their present bathymetric distribution about the beginning of Tertiary time. It is also to be noted that most modern crinoids are of more delicate construction than their predecessors, and more likely to be broken up, especially in shallow water.

Physical Constitution of the Earth.—In the *Annales de Physique*, May-June, Mr. Rokuro Yamamoto develops the mathematical theory of the passage of earthquake waves through the interior of the earth, and their refraction in passing through layers of different density. He shows that there is nothing which permits the conclusion that there is a sudden discontinuity in the density at a certain depth, such as was deduced by E. Wiechert in 1897, who assumed a central nucleus of iron, with a surface layer, $\frac{1}{8}r$ in thickness, of lower density. The mathematical treatment applied to the available observations shows that good agreement is obtained by assuming a gradual alteration of density with depth, and a calculation of the time of propagation of the Japanese earthquake of September 1923 to Paris, made on this basis, gives very good agreement with observation. M. Hamy and H. Poincaré showed in 1887 that the theory of density distribution then held was difficult to reconcile with the phenomena of precession and nutation, and A. Veronet in 1912 showed that a continuous variation in density accounts for astronomical and geological observations.

Weather at Selsey Bill.—An analysis of the climate and weather at Selsey Bill, during the years 1908–23, has recently been issued by Mr. Edward Heron-Allen. The results for the sixteen years are given, not only as being of interest to residents but also as being acceptable to those who wish to know the climatic conditions afforded by the district. The extremely small mean range and variation of temperature, the well-graduated and distributed rainfall, and the great prevalence of sunshine, render Selsey an agreeable health resort. The mean temperature for the year is 50·5° F., the mean of the maximum readings is 56·7° and of the minimum 44·5°. In the eight years 1913–20, the shade temperature did not register 80°. The highest mean temperature for the year is 53·1° in 1921, the lowest 48·5° in 1909; omitting these two years of extreme temperature the range of annual means is 5·9°, from 52·8° in 1911 to 48·9° in 1917. The average annual rainfall is 29·24 in., the annual totals ranging from 38·21 in. in 1909 to 16·34 in. in 1921; the number of days with rain average 173, ranging from 194 in 1916 to 137 in 1911 and 1921. Sunshine is very prevalent, the average days for the year with bright sunshine being 310 and the average duration per day for the year 4·98 hours. A comparison with neighbouring health-resorts in the Book of Normals published by the Meteorological Office shows Selsey to have very favourable weather conditions.

New Lines in the Spectrum of Lithium.—Observing the spectrum of the positive rays (canal rays) of lithium, M. M. Morand has discovered a number of new lines, which he ascribes to an unstable modification, ortholithium, the ordinary spectrum being due to stable paralithium (*Comptes rendus* of the Paris Academy of Sciences, June 2). The new lines are given in the following table:

Wave-length.	Intensity.		
3713	4	$1s$-$2p$	first of principal series.
4814	2	$2p$-$3s$	sharp series.
4053	1	$2p$-$4s$	
3756	0	$2p$-$5s$	
5488	3	$2p$-$3d$	diffuse series.
4244	2	$2p$-$4d$	
3841	1	$2p$-$5d$	
3653	0	$2p$-$6d$	

It is assumed that in the paralithium ion, the two electrons are in crossed 1_1 orbits, while in the ortho-lithium ion the orbits are coplanar, one being a 1_1 orbit while the principal quantum number of the other orbit is two. Details are given of the energy relations between the two modifications.

COEFFICIENT OF FRICTION FOR METALLIC SURFACES.—Experiments on the friction between different metals, in various states of polish, and without lubrication, are described by M. M. Fichter in the *Comptes rendus* of the Paris Academy of Sciences, June 2. The coefficient of friction was found to diminish up to a certain point, when the polish was improved; but increase of polish beyond this point increased the friction, so that for each pair of metals used, iron on iron, brass on brass, steel on brass, copper on zinc, there was a certain critical polish, with minimum friction. With brass-brass, for example, the coefficient of friction is lowered to about 0·12, and then increases rapidly; so that to separate the two blocks may require from 1·5 to 2 kg./cm.^{2}. To obtain plane polished surfaces, the blocks were rubbed together in water containing aluminium powder in suspension. The effect of heat and pressure on the perfectly polished blocks may produce actual union (welding), so perfect that it requires the ordinary breaking load to separate them. It is suggested that in ordinary friction, in addition to the effect due to the interlocking of the roughnesses of the two surfaces, a succession of partial welds must be produced, followed by the pulling away of elements of the surfaces which have been brought into intimate contact and welded. The tangential force of sliding friction would thus depend upon the elastic reactions of the welded parts, which are stretched to the breaking point, while new welds are produced at other points of the surface.

A NEW METHOD FOR PRODUCING SINGLE METALLIC CRYSTALS.—The method described by I. Obreimow and L. Schubnikow in the *Zeitschrift für Physik*, June 4, is a modification of that employed by Tammann, who poured melted bismuth into a small test tube, covered it with infusorial earth, and allowed it to cool slowly; when crystallisation started from a single centre, and the whole of the material was formed into a single crystal. Strelkow was able to extend the method to zinc, in which the number of crystallisation centres is larger, by introducing a small "bud" crystal at the top of a crucible full of fused zinc; the bud grew to fill the whole crucible when this was cooled from the top. The authors use a glass tube, drawn out to a capillary at the bottom; the metal is melted in the tube by means of a special electric furnace, which enables the temperature of the capillary to be controlled; the air is pumped out of the upper portion of the tube, and the capillary is cooled, an air blast being used for this purpose when necessary. If the capillary is small enough, section less than 1·5 sq. mm. for zinc, 3 sq. cm. for antimony, a single bud crystal is formed in it, and grows when cooling is continued slowly at first, from the bottom to fill the whole tube. Rods from 2 to 10 mm. diameter and 30 cm. long have been obtained with tin, cadmium, zinc, antimony, aluminium, and magnesium. By varying the shape of the glass vessel, the form of the single crystal can be altered, and flat plates or cylindrical test pieces with thickenings at each end, for attachment to the testing machine, obtained.

NEW DEVICES FOR MICROSCOPES.—An exhibition of scientific instruments which is being given by Messrs. Ogilvy and Co. at 18 Bloomsbury Square, London, W.C.1, includes a large number of the most recent designs of Leitz microscopes and apparatus for photomicrographic and micro-projection work. A full range of microscopes for binocular vision suitable for all magnifications is shown. Prominent among these is the Ore Dressing Microscope, which is specially intended for the examination of granular products of concentration. The body is of the Greenough binocular type, but has several useful additions. Each tube is fitted with a revolving eye-piece holder carrying three eye-pieces which afford magnifications of 10, 15, and 20 respectively. Below the eye-piece a slot is provided for the insertion of a ruled glass plate, by means of which the number and size of the grains may be determined. The optical portion of the instrument may be moved in two directions at right angles to one another and to the central axis of the microscope, so as to cover an area of 5×5 cm. The grains to be examined are placed on a glass plate, also divided into squares, in a mount which fits the opening in the stage. Another noteworthy exhibit is the anti-vibration device with which the new Leitz photomicrographic camera is fitted. The optical bench, which carries the microscope, camera, and illuminating system, is mounted on springs which allow it to vibrate freely, the relative positions of the various components on the bench remaining quite undisturbed. The optical bench can be clamped to the table while the preliminary adjustments are being made, and many useful and novel devices are incorporated for simplifying these adjustments. The instruments and apparatus will remain on exhibit during the months of August and September, and may be examined by anyone interested. Demonstrations are given at 11 A.M. and 3 P.M. daily, except on Saturdays and Sundays.

FUSIBLE ALLOYS.—The name "fusible metal" is usually applied to alloys having melting points below that of tin. These are binary, ternary, and quaternary mixtures of lead, tin, bismuth, and cadmium. They are used mainly in the production of readily fusible safety plugs for automatic fire extinguisher systems, but during the War petrol tanks of complicated shape for aeroplane work were made by depositing copper on a casting of fusible metal, then melting out the latter in boiling water. In a paper in *Chemistry and Industry* for July 4, read before the Society of Chemical Industry, Dr. Budgen describes the properties of fusible alloys and communicates new experiments. None of the twelve quaternary alloys was entirely liquid below 73°, nor was any entirely solid above 65·5°. The addition of 16·6 per cent. of mercury lowered these points to 63° and 50° respectively.

THE MELTING POINT OF GRAPHITE.—The *Chemiker Zeitung* of July 15 gives an abstract of a paper read at the Bunsen Gesellschaft at Göttingen in May on the melting point of graphite. The experiments were made by Ryschkewitsch and consisted in passing a heavy current through a graphite rod with a constriction. At a certain temperature this constricted portion suddenly disappears, and kinematography shows that this is not due to a gradual evaporation. The temperature was also practically independent of pressure. Calculation shows that the melting point of graphite is about 3800° abs.

Pre-Columbian Representations of the Elephant in America.

By Dr. HENRY O. FORBES.

IN NATURE of November 25, December 16, 1915, and January 27, 1916, Prof. Elliot Smith set forth very circumstantially his reasons for supporting Von Humboldt in interpreting certain features of a Stela (known as B) from Copan in Central America, as a pre-Columbian representation of an elephant's trunk. This view was combated vigorously in NATURE of January 27 by three well-known American archæologists, Dr. Spinden, Prof. Allen, and Dr. Stozzer.

FIG. 1.—Manabi slab. (After Saville.)

Elliot Smith and his school attach the greatest importance to the correctness of the elephant-trunk interpretation, since it forms one of the crucial facts on which they rest their doctrine of the transference of civilisation from the Old — especially from Egypt and India—to the New World. According to Elliot Smith, the deity, spoken of as the "long-nosed god," "who was most often depicted upon the Ancient Maya and Aztec codices was the Indian rain-god Indra, who in America was provided with the head of the Indian Elephant," seemingly "in confusion with the Indian Ganesa."

I do not claim to have made a special study of Central American archæology, but I took the deepest interest in that of Peru during my sojourn there, and I have since followed with close attention any evidence tending to indicate culture-transfer between the two worlds.

The statements of Elliot Smith seemed on their appearance by their emphatically assured tone, supported by a drawing he gives of part of the Stela, apparently to afford evidence of a contact between East and West. Yet among many anthropologists, both in England and America, grave doubts have been expressed as to his interpretation of this feature of the monolith, owing to the extreme improbability of a totally alien mythology modifying successfully a very highly specialised and altogether different one, "including practically" (as Elliot Smith asserts) "the whole of the beliefs associated with" and the acceptance of "the worship of Indra."

During a tardy convalescence I have devoted some time to a careful study of the literature bearing on this point and of Dr. Maudsley's magnificent illustrations of the Copan monuments, without which it is impossible to form an opinion upon or criticise Elliot Smith's drawing in NATURE, November 25, 1915. The result is that I have arrived at an interpretation of the "elephant-trunk," different from his, which I submit to the consideration of archæologists. The *motif* of the deity's long nose is certainly not an Indian or other elephant's trunk, nor entirely, though perhaps partly, a macaw's beak, nor probably a tapir's snout; but I suggest with some confidence it is a feature derived from one or other of the Cephalopoda—squid, loligo, argonaut, octopus, or a combination of them. This suggestion, if accepted, will, I believe, help to elucidate much of the complicated emblems in which so many Central American sculptures abound.

The cephalopodous genera I have mentioned are all denizens of the eastern or western coasts of America, and any one of them might suitably be adopted as a motive in Maya mythology. Indeed an engraved stone slab from Manabi Island (Fig. 1), off the coast of Ecuador, shows that the squid (although here provided with spurious limbs) clearly entered into the mythology of that country, if not also into that of one or more regions of South America; for I found numerous cephalopod eyes and prehensile suckers from some specially large species in many of the pre-Inca graves I excavated in Peru. On the other hand the elephant is entirely alien to America. No nation suddenly changes its mental orientation. "Mere similarity of ornament," as Mr. Joyce very truly remarks, "means nothing when the ornamentation in question is found to symbolise beliefs of an entirely different character."

It is perhaps desirable to recall the following characters in the cephalopods for purposes of the comparisons I have instituted: their long tapering serpentiform arms provided with rows of prehensile suckers; their very strong mandibles, so remarkably similar to a macaw's beak, conspicuous in the centre of their surrounding arms; their water-discharging funnel—often absurdly nose-like—opening on the mollusc's (frequently warty) body (or mantle) or between its arms; their immense round, staring black, crescent-pupilled eyes, calculated to fascinate the superstitious and the timid. Some of the species inhabiting the west coast of America possess arms a score of feet in length and mandibles far larger than any macaw's—formidable and terrorising animals if unexpectedly encountered. Members of the ten-armed section of the group have two tentacles longer than the others, terminating in an expanded club arrayed with four rows of suckers.

My interpretation of the Stela will be more easily followed if I first direct attention to a lintel repre-

FIG. 2.—Serpent-bird, from Tikal. (After Maudsley and Joyce.)

senting the "serpent-bird" from Tikal, well pictured as Fig. 17, p. 55, of Mr. Joyce's excellent "Guide to the Maudsley Collection of Maya Sculptures in the British Museum." This lintel (Fig. 2), according to Prof. Elliot Smith, reproduces "a highly Americanised representation of the 'winged disc and serpents [seen over the doors of Egyptian temples].'" Here "the god's face now replaces the disc as in some of the Asiatic derivatives of the Egyptian design. . . . A striking confirmation of this interpretation (*i.e.* the conventionalisation of the serpent's 'body' into a simple cross) is supplied by Maudsley, who has shown that the pattern below the cross" (which I have

lentified as the snake's body) " is really a very highly onventionalised serpent's head reversed." It is ith great diffidence that I venture to differ from so istinguished an authority on Central American rchæology as Dr. Maudsley. If, however, he and ther interested archæologists will follow the interetation I submit here, I hope it may prove as conincing to them as to myself.

The interpretation which I would submit is: The ikal lintel represents, in its central part, neither nore nor less than a slightly specialised argonaut or ctopus, with its beak displayed in the centre of its adiating tentacular arms, representing the " god's ace." Over it two round eyes glare out under a trongly marked corrugated " superciliary ridge." his ridge is the fleshy upper margin of the mollusc's nouth, which continues into its under-margin, ormed by a fleshy band, seen resting upon two avian arsi and toes. This lower fleshy oral border, marked y three circular pedunculated discs representing ontracted tentacles on the margin of the mouth, ives origin, right and left, to a clearly defined tentacle, n which are depicted the prehensile suckers of the nollusc in the form of raised circular knobs, and erminating in a hook-like tip. On right and left he oral marginal angles are largely concealed by vhat may be termed " ear " ornaments (with their endants), from behind which issues, on each side, a ong massive arm, extending horizontally in somewhat ngular undulations until it reaches the commencenent of the conspicuous feathered extremities of the intel, where it bends downward and outward, and nds in a hook-like tip (as in the long arm of Rossia). Along its length is sculptured an interrupted series f round elevated discs, representing prehensile entacular suckers.

Starting from the same point (but in front of his larger tentacle) there can be identified another rm, coiling downwards, with a serrated margin owards its termination, and displaying the usual uckers, coiled end, and characteristic hook-like tip. mmediately above the " ear " ornament a very short, losely coiled-up, contracted arm takes origin from he margin of the mouth, while a stage higher on the intel is seen stretching upward a very prominent rm serrated on its under margin (as in some living pecies), broadening towards its free end, and exhibting conspicuously the usual suckers. This tentacle rises on each side out of the black-edged upper oral nargin of the mollusc above the eyes, while from behind it arises yet another, easily traced by its suckers. This latter extends horizontally in the background (having attached to it the wing-coverts and quills of the feathered extremities of the panel) as far outwards as the curious mace-like objects (seen at the inner edge of the feathered area), where it descends in a wide sweep in rear of the longest horizontal arm, to terminate in a scroll which appears below its lower border in a double-hooked tip. Above the flat-ended arm still another, short and closely coiled, takes rise. Its prehensile suckers begin, in a row of circular knobs, beneath the centre of the " chin " of the small central face, on the upper edge of the lintel, and continue onwards (beneath a space-filling detail) along the coil of the tentacle. Finally, behind this detail on each side arises an arm more robust, stumpy, and even " elephant-trunk "-like than the others, the prehensile suckers of which follow along both " cheeks " of the small " face." In all, seven pairs of tentacular arms surround the parrot-mandibled mouth of this design. The digits of the avian foot beneath the lower oral boundary belong to the bird the feathers of which form the terminal ornaments of the lintel. One can easily imagine that the Maya artist, finding a marine creature with a beak so macaw-like, would feel impelled to add some avian concomitants to his sculpture. He obviously took as his model for them the bird on the relief in the Palenque Temple of the Foliated Cross (Joyce's Guide, Fig. 13).

The lintel, therefore, if these interpretations be accepted, represents not " a serpent's head reversed," but an octopus with its beak displayed, as in Nature, amid its tentacular arms, and should be designated rather a feathered octopus than a " feathered snake." In any case, this sculptured design presents in no detail the remotest suggestion of an elephant or, to my vision, of a serpent, nor does it owe any inspiration to Egypt, India, or Asia; it is purely of Maya origin.

If, bearing in mind the interpretation above suggested of " the arms," " tentacular discs," and " body outline " in the " feathered snake," a close examination be made of Plate V. of Mr. Joyce's Guide where the head of the Death-god is pictured, I venture to think a strong confirmation of a cephalopod being a Maya motive will be admitted, for upon it (Fig. 3)

Fig. 3.—Head of Death-god, face of altar-table, Copan. (After Maudsley and Joyce.)

two squids quite unspecialised are clearly sculptured. The " face of the god " anthropomorphised in having human teeth conspicuously exposed by the absence of fleshy lips, takes the place of the parrot-beak of the mollusc, and is completed by a nose with two nostrils—probably derived from the sepuncle of the cephalopod, the function of which would be unintelligible to the artist. Deep set beneath a strong " superciliary ridge " are two organs, which *seem* to be eyes. Yet they more probably represent the large tentacular suckers of the two massive fleshy arms curving up under them, recalling the stumpy tentacles of the Tikal lintel. I lean to the second alternative. If this be so, then the two prominent organs at the upper edge of the altar-face are to be identified as the god's eyes. The " superciliary ridge " forms the margin, fringed with short retracted tentacles, of the monster's body (the continuation of which probably extended over the altar-table), as well as the upper margin of its mouth. Of these small fringe tentacles, one is seen on each side of the " nose." The sulcus between them corresponds with a corrugation observable between the eyes of the " feathered serpent," and helps to support my suggestion that the dark line on that panel also indicates the upper edge of a cephalopod's mouth. Similar circular tubercles, on what are plainly the mollusc's mantle, occur also on the body of the squid carved on the Manabi slab (Fig. 1) already referred to, where there is no question as to its zoological identity. Close examination of the panel reveals on the extreme right of the " superciliary fringe " the trend of the edge (indistinct on the left side) of the oral orifice which, passing behind the robust arm, reappears below as the lower margin of the mouth—scalloped (by retracted tentacles) and " warted " as on the

higher part of the mantle—passing underneath what may be called mandibular teeth, then continuing upward to meet the mantle on the left side and complete its oral boundaries. It will be noted that the Maya conventionalism for representing the dermal surface of cephalopods is by circular tubercles. These are observable here on the surface of the body, on the notch of the "nose," on the "lip" between the

FIG. 4.—Stela B. Front. (From Maudsley's photograph.)

"nose" and the upper teeth, on the two robust tentacles, and on the lower oral margin. In the argonaut, the two central arms, when all are spread, are often so closely apposed as to appear a single very broad tentacle—a feature very conspicuous in the South Atlantic Bathypolypus.

My interpretation, therefore, of the morphology of this panel is that the whole of what forms here the "face" is delineated upon a much broadened tentacle, emanating centrally from the mollusc's body, so as to overhang and conceal its true mouth, where would naturally be seen its parrot-like mandibles, as in the "feathered serpent." The space to right and left of this broad, face-fashioned tentacle, is filled in by an unmistakable species of squid, the lower end of which rests on the base of the panel, while its oral end gives rise to a circle of prehensile tentacles, two coiling downwards and more than one upwards, while the central line of its mantle is marked by a row of circular warts, as on the Manabi slab (Fig. 1). A tentacle marked with suckers is coiled round each end of the bar over which the cephalopod is apparently holding on, disjoined possibly from its continuation on the altar-table. The right and left extremities of the panel are ornamented by an oblong detail, which I should not hesitate to determine—if asked to do so—as the eye of a large species of Ommatostrophes.

This altar-face panel, I argue, supplies the key to the intricate and foliated ornament in many Maya sculptures, in that the details are traceable to cephalopods of perhaps more than one species—indigenous emblems at all events, in which there is not the slightest suggestion of anything proboscidean.

Coming now to the Stela B, "famous for the realistic representation of the Indian elephant at Copan" (of which Prof. Elliot Smith, in his "Evolution of the Dragon," has reproduced a *front* view Fig. 19 from Dr. Maudsley's plate 36, in the volume on archæology in Godman's "Biologia Centrali-Americana"), we may compare the intricate details of the monolith with those in the two panels discussed above. If, however, the right and left front *edges* of the Stela had been figured, a full view of both "trunks" and other important details, not visible *en face*, could have been more instructively studied. Dr. Maudsley's photograph (in the "Biologia") is accompanied by an elucidatory diagram to render the intricate decoration of the stone more easily followed. This diagram does not, however, quite faithfully reproduce the sculpture, and as its upper portion has been used by Elliot Smith to illustrate his letter in NATURE of November 15, 1915, it is very misleading, as will presently be noted.

The feature, on both "trunks" (Fig. 4), interpreted as a nostril, due to the ignorance (?) of the Maya artist, is clearly in its shape and more or less accurately as to its position a cephalopodous eye, like that of Sepiola, situated, as it should be, on the animal's body or mantle. Turning attention now to the right-hand upper corner of the statue, we discover there Elliot Smith's "auditory meatus." On the left of the "trunk" is (as the photograph, Fig. 5, sufficiently testifies) a tentacular arm issuing from a fold of the mollusc's body (the "forehead" of the elephant) and so coiled up as in Rossia that it ends in a close circular spiral, armed throughout its length with its rows of prehensile suckers. On the right of the trunk the origin of this coiled-up tentacle ("auditory meatus") is concealed by a flamboyant bouquet of tentacles, the suckers of which are nevertheless to be seen between and behind the flambeau. This "scroll below the ear as well as the tree-like appendages above the head," are in Elliot Smith's view "parts of the conventional waves breaking around the *sea-type* of Indian Makara." Yet the elephant of the Stela is a mahout-riding species! I feel convinced, nevertheless, that the "ear-pinnæ" of Elliot Smith (arising from behind the bar-like detail on which are seated the two human figures visible on the front aspect of the monolith) are undoubtedly cephalopod arms recalling those of Cledone. They coil round beneath the "meatus" tentacle, and end in a sharp thorn-like tip (as in Rossia) projecting conspicuously from the plane of the Stela—surely an unusual appendage to an ear-flap. These tentacles, as drawn in the

FIG. 5.—Stela B. Right-hand edge. (From Maudsley's photograph.)

elucidatory diagram, unfortunately show none of the suckers definitive of their function, though they are clearly represented in the photograph. Above both these details another (rather damaged) tentacle can be traced at the summit of the monolith on each side coiling upwards and inwards from a fold of the mollusc's body (the "elephant's" head)—none of them analogous to any organ in a proboscidean.

Studying now the corresponding angle on the left side of the monolith (Fig. 6) we see a bodyless turbaned head poised on the mollusc's body (the "elephant's" neck). This is interpreted by Elliot Smith as a mahout. On the elucidatory diagram are delineated

his driver with his braceleted hand and bent arm esting on the "elephant's forehead," and also the dge of his so-called "driving-stick" and the tips of is fingers. The Stela, however, shows absolutely no uch features. Were the arm correctly drawn in the iagram, it must originate from the driver's ear, for e has no fragment of a shoulder, no body, no arms or ands—a head only—the braceleted wrist and arm re imaginary. Underneath the "mahout's" chin riginates (as on the corresponding dextral aspect) a tentacle as a closely coiled spiral (again the "auditory meatus") with its prehensile suckers. More to the left the mollusc's body gives off a second tentacle, which meets a third, coiled up reversely, all of them armed with prehensile suckers. The ridge seen in the front view, under wh ch the bent arm of the rider is drawn in the diagram, is clearly the fleshy edge of

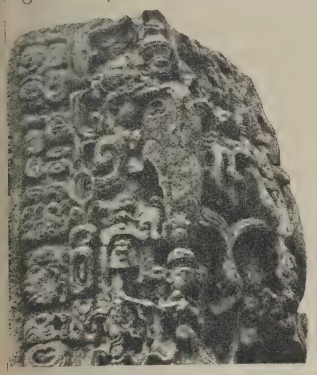

FIG. 6.—Stela B. Left-hand edge. (From Maudsley's photograph.)

he mollusc's body, corresponding to that on the ight side of the "trunk" on the right corner. From he body of the cephalopod, just beneath the "rider's" hin and above the eye which is overshadowed by t, there clearly originates from the mollusc's body a nore slender tentacle, overlaid upon the "trunk," he function of which is denoted by its prehensile uckers. How erroneously this detail has been inter- reted as a mahout's driving-stick—which he has no rm or hand to hold—an inspection of the photo- raph of the Stela itself, our sole witness, proves. The right-hand "trunk" carries no mahout and shows o "driving-stick."

Both the "trunks"—neither of which, by the way, is accompanied by tusks although Elliot Smith efers to such a feature—are, therefore, but very arge robust tentacles (one enlarged tentacular arm s not an unfamiliar character in living cephalopods) he suckers of which are indicated by the cross- natching instead of by the usual circular tuberculations, confusing perhaps macaw with cephalopod emblems. The mollusc's body, therefore, gives off around the "trunk" and "head" quite an array of tentacular arms which cannot be associated with anything in proboscidean anatomy. The supposed mahout is not the only human figure on the Stela. Two are seen in the front view, sitting between the two "trunks"; while down both its front edges, below the level of the "trunks," is sculptured a series of figures, or only heads, all of them on the Stela itself, turbaned as in the Rain-god, but none of them showing any proboscidean relationships. They have neither "trunks" to sit on nor "sticks" to drive with. If they are not mahouts, neither may the uppermost figure (seated on the mollusc's mantle) be so interpreted. As this supposed "driving-stick" turns out to be a cephalopodous tentacle, *cadit quæstio*, both as regards the trunk and the mahout.

Moreover, the turban of the "Rain-god" presents a most suggestive and interpretative "ornament." This symbol—if the two panels already discussed be kept in mind, especially that representing the Death-god—clearly represents a cephalopodous animal. On each side (the right broken) of the turban (Fig. 4) there hangs down an octopod (?) tentacle, with its free tip exactly recalling that of the longer arm in the "feathered snake" and of Argonauta or Rossia, both showing the usual circular tuberculations representing prehensile suckers. On the top of the turban and on each side a second suckered tentacle is coiled, while rising perpendicularly from the centre of its crown is seen what is quite easily resolvable into two tentacles, armed with suckers, closely applied edge to edge, as in the argonaut, but diverging half-way up to embrace a "cartouche" enclosing emblems quite in keeping with the motive—three prominent suckers, then still ascending to end in a lingulate finial.

That the cephalopod motive is a real one in South American mythology is evident from the Death-god panel and the Menabi slab; but further confirmation comes from the presence of at least one unmistakable cephalopod in the centre of the beautifully decorated reverse of the monolith (Fig. 7), where it gives off two downward coiled tentacles and two long upwardly directed arms with their characteristic terminal hook and prehensile discs. Cephalopodous emblems run riot indeed over the statue on all its sides, while not a single detail (except the mistakenly named "trunks") recalls anything in the anatomy or life of an elephant of any species, or of any creature alien to America.

It is possible, from my point of view, to interpret in the same sense the emblematic decoration in more than one of the Copan mythological designs—to name only two: the left upper vignette on the Dresden Maya Codex (Fig. 11, Joyce's Guide); and especially the left glyph in the upper row of his Fig. 6 of "Full-figure Numerals." I may add also the glyph figured by Dr. Spinden, Fig. 1, *c* in NATURE of January 27, 1916, which is combined with the macaw motive.

In his letters to NATURE referred to above, Prof. Elliot Smith avers that the scroll (representing the pinna) "was an essential part of the elephant design before it left Asia"; that "the sculptor was not familiar with the actual animal"; that he "has mistaken the eye for the nostril and the auditory meatus for the eye"; has represented "the ventral

FIG. 7.—Stela B. Part of the reverse of the monolith. (From Maudsley's photograph.)

surface of the trunk in a conventionalised manner without any adequate realisation of the true nature of the features he was modelling"; and that "having converted the auditory meatus into an eye he converted the pinna into a geometrical pattern" which "he was careful to restrict to the area occupied by a relatively small pinna that is distinctive of the Indian species." Yet, notwithstanding these many defaults of memory which are charged to the Maya sculptor,

one cannot fail to marvel that he could draw the outline of the head so accurately as to enable a zoologist to identify the original model as the Indian species and to distribute its various errors with so much acumen.

Elliot Smith's ardent supporter, Mr. Perry, provides us with a fact that increases still more our amazement: the "movement of culture," he tells us, "that set out from Egypt" [always as stressed by Rivers without their women folk] "about the beginning of the fourth millennium B.C., ultimately landed in America [after centuries spent in India, Indonesia, and Polynesia] about the beginning of our era and there founded civilisations essentially the same as that of Egypt in the Pyramid Age. . . . This movement took 3000 years, more or less, to accomplish the journey, but it can be traced with fair accuracy for thousands of miles." It is therefore scarcely surprising not only that the god Indra was confused with Ganesa and that certain features —nose, ear, pinna, turbaned rider—of the elephant head during that period became but a memory to the bearers of the heliolithic civilisation to America, but that any resemblance even of the outline of its (tuskless) head and the appropriateness of a "driver" were so well conserved, especially as Elliot Smith assures us that the motive on the Stela was not the land elephant but "the sea-elephant design of the mythical Makara [a snouted monster with large prominent tusks and a fish's tail, which never existed on land or sea, and never carried a mahout] which was the commonest form of elephant spread abroad by the sea-men of Southern India copied from an earlier model (or *picture*, according to Elliot Smith) [made thousands of years before] by some immigrant from Asia." Imagine a picture—on what material soever depicted—surviving all these millenniums among a people who were only "food-gatherers" in the palæolithic stage when the heliolithic missionaries arrived among them!

Which is more likely to have inspired the Maya sculptor, a mythical animal, the memory of which 3000 years must have paled to obliteration, the outlines, moreover, of which had never been seen by any human eye; or creatures familiar to him in his own seas, which must have excited his dread, and aroused his artistic sense?

I have to acknowledge Dr. Maudsley's photographs in the "Biologia" as the source of the above figures and his kindness in permitting me to use them, and to thank Mr. J. Edge-Partington for sketching Fig. 1 for me.

The British Medical Association at Bradford.

Tissue Culture.

At the ninety-second annual meeting of the British Medical Association held at Bradford on July 22-25, Dr. Alexis Carrel, of the Rockefeller Institute, New York, opened a discussion on the method of tissue culture and its bearing on pathological problems. The present position of tissue culture *in vitro* was clearly summarised, and considerable space was devoted to the most recent view of American workers that there are growth-promoting substances—trephones—which are secreted by certain cells of the body to minister to the nutritive wants of other cells. It is believed that leucocytic trephones play an important part in physiological and pathological processes. They secrete substances, *in vitro* and *in vivo*, and enable fibroblasts to grow readily.

Immunity.

At the same meeting, Dr. R. A. O'Brien, of the Wellcome Physiological Research Laboratories, opened a discussion on immunity, with special reference to specificity and the influence of non-specific factors. It is now a hundred years since the great French clinician Bretonneau, from a mass of observations, set free the doctrine of specificity in disease. His particular contributions referred to enteric fever and diphtheria. After long years of confusion, Dr. William Budd, in the 'sixties of last century, again placed the doctrine of specificity on a sound basis, both with respect to enteric fever and to tuberculosis. The exact experiments of Robert Koch from 1876 onwards established the specificity doctrine on an irrefutable basis, which was again extended through the discovery of antitoxin by Behring and Kitasato in 1890. Since that time every well-authenticated observation on man or animals has confirmed the specificity of infective virus.

It has been claimed, however, that certain substances which are non-specific in the sense that they have no direct or immediate affinity with the specific causes of disease, may act in a curative manner. It is the published data on this point which Dr. O'Brien has analysed. In certain instances he has subjected the question to experimental inquiry, and has been unable to find evidence that non-specific substances influence favourably specific experimental infections or intoxications. Against this is a slowly growing mass of clinical observation, which seems to point to therapeutic successes in a variety of diseases. Protein substances such as occur in milk, blood serum, and egg are claimed to be endowed with curative properties believed to be great or even extraordinary. We have recently been asked to believe that injection of milk will cure duodenal ulcers.

Many clinical observations are without much value on account of their uncritical character and the complexity of the factors involved. This non-specific therapy may be a fashion in therapeutics. At all periods there have been many such. It is said that a new drug should be exhibited while it *still* cures. It is also well not to forget that medicine still retains many of the characteristics which it had nineteen hundred years ago, when Celsus wrote, "Medicine is a conjectural art, and the nature of conjecture is such that although it answers for the most part, yet sometimes it fails."

The Microscopy of the Living Eye.

When von Graefe first saw the fundus of the living eye with Helmholtz's ophthalmoscope in 1851 he is said to have exclaimed, "Helmholtz has unfolded to us a new world! What remains to be discovered!" Indeed it is questionable whether any single physical invention has been a greater boon to medical science than the ophthalmoscope. The latest development of ophthalmoscopy is the microscopy of the living eye, the technique of which has been elaborated by several ophthalmologists but chiefly by the celebrated Allvar Gullstrand of Uppsala. Briefly stated, the method consists of illuminating the living eye by a narrow beam of light furnished by a nitra slit-lamp and condenser, and with diaphragms of various small apertures. The details of the structures so illuminated are observed obliquely either by the "teleloup" or Czapski's binocular microscope. The teleloup consists of a pair of miniature opera-glasses fixed on a spectacle frame. It gives a stereoscopic image with a magnification of about two diameters. With the microscope, nine diameters or more of magnification can be obtained.

The practical value of this new method of microphthalmoscopy formed the subject of an interesting discussion in the Ophthalmological Section, from which it is obvious that it has already yielded results of considerable scientific and practical interest. In opening the discussion, Mr. Basil Graves dealt with the physiological aspect of these results. He showed that it was possible by delicate adjustment of the illumination to demonstrate that the aqueous humour, the most pellucid of the body fluids, is not absolutely transparent, but that the range of what might be regarded as normal relucency could be determined. He has also detected varying degrees of metallic lustre in the crystalline lens, which he attributes to internal reflection from the lamellar surfaces in the interior of the lens itself.

Dr. Harrison Butler's *résumé* of the diagnostic aids which the new technique has already yielded in his hands affords an ample justification for its introduction into the practice of ophthalmology, and gives promise of further useful developments. The exact depth to which ulcerations have extended, and the localisation and extent of inflammatory processes in the cornea, can be determined with accuracy. The various forms of cataract can be detected in their earliest stages, and differentiated from one another with greater precision than heretofore. As the subsequent course and the treatment required for these several forms of cataract are widely different, it is, of course, important to be able to distinguish them early and surely. Another highly important application is in the early diagnosis of the much-dreaded sympathetic ophthalmia, by which disease many perfectly sound eyes are lost as the result of septic infection of the opposite eye. If the diagnosis is made sufficiently early, the good eye can be saved by prompt removal of the damaged eye. The detection of slight increase of turbidity of, or minute floating particles in, the fluid in the anterior chamber is the danger signal in this condition. Most of the points touched upon by the openers of the discussion are much better appreciated by demonstration than by description, consequently the interest of the meeting was focussed largely on the drawings and figures by which the papers were illustrated.

Edinburgh Conference on the Vegetative Propagation of Plants.

TO botanists and horticulturists all over the world the fame of the Botanic Garden at Edinburgh requires little comment. The collection of trees and shrubs is one of its many features; its Rock Garden alone has made it famous. So remarkable is the collection that a leading botanist from abroad was struck, not by the vast number of interesting plants, but by the fact that there are so few uninteresting ones. But the plants which meet the eye of the visitor are largely the production of that deft manipulation in the propagating pits screened from the general view, where much patient work is apt to be overlooked. Only those who have had the experience know the difficulties which so often beset the gardener who has to deal with the growing of a large representation of the world flora.

To make more generally known some of the experiences gained in the Royal Garden at Edinburgh, a well-attended Conference on the Vegetative Propagation of Plants was held on July 17 and 18 under the auspices of the Botanical Society of Edinburgh. By permission of Prof. W. Wright Smith, Regius Keeper, the meeting was conducted at the Garden, and in the large laboratory attached thereto there was on exhibition about 300 species of seed-plants, supplemented by nearly 200 photographs, illustrating various methods of propagation from stem, root, and leaf as practised by Mr. L. B. Stewart, who is in charge of the Department of Propagation. Some of the results obtained in actual practice are remarkable enough in themselves, but an added interest lies in the wide field for anatomical and physiological investigation which they throw open. It is fortunate that close co-operation exists between the Garden and the University Department of Botany, and numerous problems arising out of the experience of the cultivator are under investigation at the hands of the botanist.

Certain specific questions have already received attention and these were brought before the Conference. Thus, in the genus Clematis, it is found that stem-cuttings root freely when the cutting is made through an internode but usually not at all if cut at the node. Miss Edith Philip Smith dealt with this problem and showed that the peculiarity may be related to the large amount of sclerenchymatous tissue occurring at the nodes, since it is found that if stems are etiolated before the cuttings are prepared, rooting from the node takes place readily. Etiolation is considered to act in two ways, resulting in a softening of the mechanical tissues of the stem and in a restoration of the carbon-nitrogen ratio which is regarded as necessary for establishing meristematic activity.

Mr. L. B. Stewart dealt with the propagation of plants possessing horizontal branches, taking Napoleona and Gardenia as special cases. In the former, a non-orthotropic branch-cutting gives rise to a new individual which fails to establish a vertical shoot axis. In the course of time, however, an adventitious bud may develop from the root system to produce an ordinary orthotropic stem. In Gardenia, a cutting prepared from a horizontal branch leads to the establishment of a new plant quite distinct in growth-form from the parent. No leading shoot is formed and horizontal branching does not occur; moreover, the new individual is precocious in flowering. Mr. Stewart discussed also the results of propagation from roots, dealing especially with Pelargonium and *Acanthus montanus*. In the latter, the form of plants raised from root-cuttings is juvenile or adult according to whether young or old portions of the root are used.

Propagation by means of leaves formed the subject of a communication by Dr. R. J. D. Graham. In leaf-cuttings of dicotyledons which do not possess succulent leaves the root system is first established, followed by the development of the shoot. The time of appearance of the shoot seems to depend to some extent on the viability of the leaf. In monocotyledons, however, shoot buds appear before the formation of roots, and succulent leaves of dicotyledons behave in the same way.

Dr. Graham gave an account also of the propagation of bulbous plants by making use of the bulb scales. In Ornithogalum, Drimia, and Hæmanthus, isolated bulb scales are exposed to sunlight to allow the mucilage of the injured surface to dry. The leaf bases are then laid on sand, watered once in ten days, and within four weeks numerous bulbils begin to develop on the adaxial side of the scales. This provides a quick method of obtaining large supplies of saleable bulbs. The induced buds arise in Ornithogalum from meristematic tissue near the leaf base. In Drimia, bud formation may be induced either in the parenchyma cells of the scale or in the callus formed on the injured surface. In Hæmanthus, buds arise from the hypodermal layers of the detached leaf base.

University and Educational Intelligence.

CAMBRIDGE.—Dr. G. H. F. Nuttall, Magdalene College, has been re-elected into the Quick professorship of biology. D. L. Burn, Christ's College, has been elected Wrenbury scholar in economics.

As indicative of the growing place that organised research is holding in the University, a list of studentships awarded by the various colleges at the end of the past academic year may be of interest. At Peterhouse, W. A. Wooster (physics) and W. G. East (history); at Christ's College, A. L. Peck (classics) and D. L. Burn (history); at Magdalene College, G. E. Watts (chemistry); at St. John's College, W. H. Dew (chemistry), T. G. Room (mathematics), G. R. Potter (history), L. H. Titterton (Oriental languages), J. D. Cockcroft (mathematics), T. A. A. Broadbent (mathematics), and F. H. Constable (chemistry); at Pembroke College, H. G. Handisyde (history) and W. J. V. Ward (chemistry); at Gonville and Caius College, A. B. C. Cobban (history), R. Raper (chemistry), I. F. D. Morrow (history), W. I. Jones (chemistry), E. A. Guggenheim (physics), J. T. Irving (biochemistry), W. A. Waters (chemistry), H. T. Deas (classics), and J. C. Jones (physics); at King's College, A. Fletcher (mathematics), H. S. Kenward (classics), C. A. E. Lee (history), G. H. W. Rylands (English), and C. F. Sharman (physics); at Clare College, M. A. F. Barnett (physics). In addition, at certain colleges, notably Trinity College, scholarships are renewed for graduates doing research, so that there is a very marked move in the direction of the endowment of post-graduate research in Cambridge.

LEEDS.—An advanced course of twenty lectures on astronomy will be given on Monday evenings throughout the first and second terms of the session 1924–25, by Dr. S. Brodetsky, reader in applied mathematics, and Mr. R. Stoneley, assistant lecturer in applied mathematics and astronomical observer. Demonstrations will be given in the Cecil Duncombe Observatory. The syllabus includes lectures on such subjects as theories regarding the origin and age of the Solar System, stellar magnitudes, classification of spectra, distribution of stellar motions, double and variable stars, nebulæ, and so on. The lectures will assume such an elementary knowledge of astronomy as is represented by the popular courses given in the University. Advanced mathematical methods will not be used.

Dr. Albert Haworth has been appointed lecturer in chemical pathology. For three years Dr. Haworth has been on the staff of the Pathology Department of the Victoria University of Manchester.

LIVERPOOL.—The late Prof. Grenville A. J. Cole, Director of the Geological Survey of Ireland, and professor of geology in the Royal College of Science, Dublin, expressed a wish during his life-time that his valuable collection of separate geological papers should find a home in the University of Liverpool. After Professor Cole's death recently, his executors forwarded his collection of more than 3000 geological papers to the Department of Geology of the University.

LONDON.—Dr. Morris Ginsberg has been appointed as from August 1 to the University readership in sociology tenable at the London School of Economics.

The title of professor of electrical engineering in the University has been conferred on Mr. J. T. MacGregor-Morris, in respect of the post held by him at East London College.

The title of reader in physical chemistry in the University has been conferred on Mr. W. E. Garner, in respect of the post held by him at University College.

The title of reader in public administration in the University has been conferred on Mr. H. B. Lees-Smith, in respect of the post held by him at the London School of Economics.

The title of emeritus professor of education in the University has been conferred on Prof. J. W. Adamson on his retirement from the University chair of education at King's College.

Prof. H. R. Kenwood has resigned from the Chadwick chair of hygiene at University College as from December next. At a recent meeting, the Senate expressed appreciation of his long and valued services to the College and to the University.

The Senate has approved proposals for affording guidance to external students in their studies. The proposals are designed to meet the needs of those who are unable from any cause to follow courses of instruction either in Colleges or Institutions of the University or in other universities, or in university colleges in other parts of the country. External students finding difficulty in arranging courses of study may consult the External Registrar.

The following Doctorates have been conferred: *D.Sc. in Physics*: Harry Moore (King's College), for a thesis entitled "The Corpuscular Radiation liberated in Vapours by Homogeneous X-Radiation"; *D.Sc. in Chemistry:* A. D. Mitchell, for a thesis entitled "The Reactions of Phosphorous and Hypophosphorous Acids, with Special Reference to the Evidence they afford for the Tautomeric Character of the Acids," and other Papers; *D.Sc. in Physics:* A. M. Mosharrafa for a thesis entitled "The Quantum Theory of Radiation," and other papers.

MANCHESTER.—The following appointments have been made: Reader in surgical pathology, Mr J. Howson Ray; Lecturers in surgical pathology, Mr. P. R. Wrigley and Mr. Garnett Wright; Assistant lecturers in chemistry, Mr. Wilson Baker and Mr Bernard Cavanagh; Demonstrator in physiological chemistry, Dr. P. W. Clutterbuck. Prof. S. J. Hickson has been reappointed to the chair of zoology for a further period of two years.

ST. ANDREWS.—The Royal Commissioners for the Exhibition of 1851 have, on the nomination of the University Court of St. Andrews, awarded an industrial bursary of from £140 to £175 to Mr. Frank Gardiner Forbes, a student of engineering in University College, Dundee.

WALES.—Dr. E. H. Kettle has been appointed professor of pathology and bacteriology in the Welsh National School of Medicine (University of Wales), Cardiff.

SIR GILBERT T. WALKER, who has recently completed a period of about twenty years' service as director-general of Indian Observatories, has been appointed professor of meteorology at the Imperial College of Science and Technology, South Kensington, in succession to Sir Napier Shaw, who is retiring on August 31.

THE Higher Education Sub-Committee of the London County Council is recommending the Education Committee to award Robert Blair Fellowships, each of the value of 450*l*., to Mr. G. Bird and Mr. J. d'A. Clark. Mr. Bird, who is now with the Westinghouse Brake Company, will investigate signalling and train control problems in the United States, while Mr. Clark, who is at the Sittingbourne Paper Mills,

proposes to study the production of wood pulp in the large pulp mills of Canada.

THE Ramsay Memorial Fellowship Trustees have made the following awards of new fellowships for the session 1924–25, the place at which the award is tenable following the name of the Fellow in each case: British Fellowship of 300*l.* to Mr. S. W. Saunders—University College, London; Glasgow Fellowship of 300*l.* to Mr. A. Robertson—University of Manchester; Danish Fellowship of 229*l.* to Mr. K. J. Pedersen—University of Bristol. The following fellowships have been renewed: Dr. S. Coffey (British Fellowship)—University College, London; Dr. A. Titley (British Fellowship)—University of Oxford; Mr. Thomas S. Stevens (Glasgow Fellowship)—University of Oxford; Dr. Miguel Crespi (Spanish Fellowship)—University College, London; Dr. J. Kalff (Netherlands Fellowship)—University of Manchester; Dr. H. Weiss (French Fellowship)—Davy-Faraday Laboratory, Royal Institution; Dr. E. Boomer (Canadian Fellowship)—University of Cambridge. Sir Robert Robertson has been appointed a member of the Ramsay Memorial Advisory Council in succession to the late Sir James Dobbie.

IN "The Londoner's Education" (London, Hodder and Stoughton, pp. 58, 9*d.*), the Education Officer of the L.C.C. presents a popular account of the services of the Council as Local Education Authority, this being one of a series of handbooks "on the L.C.C. and what it does for London." The publication of these booklets is a new departure—interesting both as a means of promoting intelligent interest on the part of the citizens of London in the work of their local government and as a commendable example of municipal advertising. The writer lays stress on the admirable progress made in the field of elementary education and the wonderfully complete provision for defective and tuberculous children, London being in this respect able to challenge comparison with any city in the world. The expenditure on schools for these unfortunates is 4 per cent. of the total cost of the education service. The most remarkable thing about the appropriations of funds to the various kinds and grades of education is that the annual grants to the University of London and colleges and polytechnics for education of university standard amounts to only 0·7 per cent. of the total.

IN the early part of this year the Governing Body of the Imperial College of Science and Technology was enabled, by generous donations from the Rt. Hon. Sir Arthur Acland and Sir Otto Beit, to establish a scheme of ten Dominion scholarships for research work in science tenable at the College during the academic year 1924–25, open to university graduates in the several Dominions and in India. With the co-operation of the India Office and the Colonial Office respectively, appointments to these scholarships have now been made by the respective Governments as follows: *India*: Mr. Sarbbanisahay Guha Sircar (Calcutta University), and Mr. A. S. Gancean (University of Madras). *Australia*: Miss M. I. Collins (University of Sydney) (for work in economic botany, including forestry), and Mr. A. S. Fitzpatrick (University of Melbourne) (for work in applied chemistry, specially in relation to fuels). *Canada*: Mr. Armand Circe (École Polytechnique, Montreal), and Mr. R. J. Henry (University of Toronto). *New Zealand*: Mr. H. L. Richardson (Victoria University College, University of New Zealand), and Mr. H. O. Askew (Canterbury College, University of New Zealand). *South Africa*: Mr. Hans Pirow (for mining engineering), and Mr. Lawrence P. McGuire (for plant physiology).

Early Science at the Royal Society.

August 3, 1664. The experiment of the velocity of descending bodies was tried with three leaden balls of different sizes. The height of their descent was sixty-one feet. Mr. Hooke was desired to find some convenient place in Westminster or Paul's for the prosecution of these experiments in a place free from wind.

August 4, 1686. A letter of Mr. William Molyneux of Dublin, to Mr. Halley, was read, wherein he owned himself fully satisfied of the performance of Mr. Hooke's level; promised what account he could of the tides on the coast of Ireland, and gave his sentiments about the properest way for actual mensuration, in order to survey a degree of the earth.

August 5, 1663. Sir Gilbert Talbot received the thanks of the Society for sending them the mace, which his majesty had given them, without taking any fees.—Sir Robert Moray produced again the stones taken out of the Earl of Balcarre's heart, and desired that the figure of them might be drawn; and Dr. Wilkins moved, that it might be taken in plaister: the care of both which was committed to Mr. Hooke.

1682. Ordered—That the list be printed with several titles distinguishing all the fellows . . . and that a little mark be made before the names of such as have been benefactors, and such as frequently account for their arrears: and that the president intimate to the Society, that he hopes they will esteem such, who shew their affection to the Society this way, as more properly eligible for office.

August 6, 1662. Mr. Wilde was desired to communicate his method of laying leaf-copper without tarnishing.—Dr. Charlton was desired to give in writing the account of the boy killed by lightning.—Dr. Goddard brought in an account of his experiments of weighing glass canes with the cylinders of quicksilver in them, according to the Torricellian experiment; which was ordered to be registered.

1668. A microscopical observation devised by Mr. Hooke, was made on a little lump of charcoal of fir-wood, in which appeared here and there interstices or partitions intersecting the great pores. Several of the members saw it and were satisfied.—Several queries were proposed about the texture of trees.

August 7, 1661. Mr. Henshaw produced a stone called "Astroites" or "Lapis stellaris," of which the following account is registered; That it moved with a little vinegar upon a declining plate several times repeated; and that it was observed, that the stone grew somewhat hot, and brak at the top. It is to be remarked, that there are two sorts of "Astroites," the one marked with starry spots, and the other stellate in its form.—Dr. Wilkins was desired to try salt-petre in water, to see if it increased in bulk.

1679. The Society adjourned for the ensuing vacation, not to meet again till summons given; but such members as pleased to meet to discourse in the mean time, might do so at the repository or library on Thursdays in the afternoon, where there would be some entertainment for them.

August 8, 1666. The president reported, that the experiment mentioned April 18, 1666 by Mr. Povey, of a new way of laying on colours, had been made that morning by Mr. Streeter at his house before himself, Sir Robert Moray [and others] viz., that an egg was beaten yolk and white together, with a few shreddings of a fig-tree branch, whereby the egg was reduced into an oily substance, without any tenacity or ropiness, so that it would be ductile, and fall on the pencil like oil.

Societies and Academies.

LONDON.

Faraday Society, July 7.—Sir Robert Robertson, president, in the chair.—G. R. D. **Hogg**: A note on the conduction of heat down the necks of metal vacuum vessels containing liquid oxygen. Approximate methods are given for calculating the "neck loss" of metal Dewar flasks containing liquid oxygen. These may also be used for determining the most suitable dimensions for the inner neck of a metal Dewar flask, the other dimensions of which are known.—C. L. **Haddon**: The mechanism of setting of calcium sulphate cements. There are fundamental differences in the hydration processes between plaster of Paris, flooring plaster and anhydrite. Further evidence in favour of Desch's theory of crystal thrust as the cause of expansion is put forward. There is a similarity between the coherence of calcium sulphate cements and that of metals.—J. J. **Doolan** and J. R. **Partington**: The vapour pressure of tellurium. The vapour pressure of sulphur has been determined in various ways, and at least one determination of that of selenium has appeared. The vapour pressure of tellurium, however, has, apparently, not previously been measured. Its value, at least approximately, has been determined at different temperatures.—E. E. **Turner** and W. H. **Patterson**: Cryoscopy in sodium sulphate decahydrate. The molecular weights of a number of sodium salts have been determined, using sodium sulphate as cryoscopic solvent, a method first investigated by Löwenherz, whose results have, in general, been confirmed. Abnormal results were obtained for the molecular weights of sodium oxalate and borax. The low result for the former substance is not due to solubility effects, whilst the molecular weight obtained for borax is in good agreement with the value obtained by Boutaric, Chauvenet, and Nabot, using sodium thiosulphate as solvent.—D. B. **Macleod**: The viscosity of binary mixtures.—J. B. **Firth** and F. S. **Watson**: The catalytic decomposition of hydrogen peroxide solution by animal charcoal; the production of highly active charcoals.—A. J. **Allmand** and A. N. **Campbell**: The electro-deposition of manganese. The best conditions for the electro-deposition of pure manganese consist in the electrolysis of a solution containing manganous and ammonium sulphates (the catholyte) separated by a diaphragm from the anolyte (ammonium sulphate solution), the H· concentration being kept at 10^{-6} to 10^{-8} by the regulated addition, as required, of sulphuric acid or of ammonia. The temperature is 30° C. and the current density at the cathode 10-15 amps./d.m. The rotating aluminium cathode has a burnisher lightly pressing against it. Electrolyte manganese contains a considerable quantity of dissolved hydrogen, which is not, however, responsible for its brittle nature.—J. **Grant**: Concentration-cells in methyl alcohol. Part II. Solutions containing tetraethyl ammonium iodide.—F. H. **Jeffery**: The electrolysis of solutions of potassium oxalate with a tin anode, and an electrometric determination of the constitution of the complex anions formed. Electricity passes from anode to anolyte in accord with the equation—

$$Sn + 2C_2O_4'' - 2\ominus = \{Sn(C_2O_4)_2\}''.$$

A solid phase corresponding with this complex ion,

$$K_2\{Sn(C_2O_4)_2\}.H_2O,$$

can be isolated. When the tin anode is coated with finely divided metal and the products of electrolysis allowed to accumulate on it, anodic oxidation takes place probably in accord with the equation—

$$\{Sn(C_2O_4)_2\}'' + C_2O_4'' - 2\ominus = \{Sn(C_2O_4)_3\}''.$$

A solid phase derived from tetravalent tin is formed, but it has not been determined whether it is of the form $Sn(C_2O_4)_2$ or $K_2\{Sn(C_2O_4)_3\}$. No tin is deposited on the cathode during this stage. The anode potential remains constant for a wide range of current density provided the anode be kept free from finely divided metal and the products of the electrolysis: failing this precaution it may rise to more than nine volts referred to the normal hydrogen electrode as zero, the current being 0·1 amp. The Darwin thread recorder has been adapted to the measurement of variations of the electrolysis current and also the time-integral of this current. It shows the rapidity of the change from the stage of the formation of the stanno complex alone to the stage of anodic oxidation.—F. J. **Fraser**: An improved form of Crook's elutriator.

CAMBRIDGE.

Philosophical Society, July 14.—Mr. C. T. Heycock, president, in the chair.—E. V. **Appleton**, K. G. **Emeléus**, and M. **Barnett**: Some experiments with an α-particle counter. The "wave-form" and intensity of the transient impulses resulting from discharges stimulated by single electrified particles have been determined using a cathode-ray oscillograph. The nature of the impulse is determined largely by the capacity and resistance of the system. The potential impulse normally detected by string electrometer methods is proportional to the current responsible for the re-charging of the electrostatic capacity of the counter after the rapid discharge of the capacity initiated by the electrified particle. When the pressure in the ionisation chamber is made less than that at which self-restoring action is possible, persistent oscillations are found. These represent the periodic charging of the counter capacity after its periodic discharge between the point and the plane. The impulses normally produced by α-particles are thus represented by one unit of the sustained oscillation. The total quantity of electricity circulating round the system when an α-particle enters the chamber is, in normal cases, of the order of 10^{-10} coulomb, but in low resistance circuits may be made 10^{-6} coulomb. The "energy trigger ratio" of the counter for α-particles, which represents the ratio of the energy released in the system to that of the electrified particle acting as stimulus, is normally of the order of 10^5, but may be made as high as 10^9.—J. E. **Littlewood**: On the zeros of the Riemann zeta function.—S. **Lees**: A case of steady flow of a gas, in two dimensions.—P. A. M. **Dirac**: Note on the Doppler principle and Bohr's frequency condition.—B. M. **Sen**: The applicability and deformation of surfaces.—E. C. **Titchmarsh**: A system of linear equations with an infinity of unknowns.—J. B. S. **Haldane**: A mathematical theory of natural and artificial selection. Part II. Expressions are found for the effects of various degrees of self-fertilisation, inbreeding, assortative mating, and selective fertilisation, on the composition of Mendelian populations, and the progress of natural selection in them.—H. W. **Turnbull**: The vector algebra of eight associated points, of three quadric surfaces.

CALCUTTA.

Asiatic Society of Bengal, July 2.—Gilbert T. **Walker**: On the wings of gliding birds. A peculiar feature in the structure of the wings of gliding birds is comparable to a device adopted in the construction of Handley-Page aeroplane wings.—E. W. **Gudger**: The sources of the material for Hamilton-Buchanan's "Fishes of the Ganges," the fate of his collections, drawings and notes, and the use made of his data.—

L. M. **Davies**: Notes on the geology of Kohat, with reference to the homotaxial position of the salt marl at Bahadur Khel. The beds at Kohat are homotaxial with the beds at Bahadur Khel.—Baini **Prashad**: Revision of the Japanese species of the genus Corbicula.—W. **Ivanow**: (1) More on the sources of Jami's 'Nafahat.' A summary description of the rare work, Risāla-i-Iqbāliyya, containing an account of the discourses of 'Alāu'd-Dawla Samnānī (d. 1336). (2) Imam Ismail. New information concerning Ismail, the sixth Imam of the Ismailiyya. It was found in a rare and early book on Shi'ite tradition, by Kashī, dating from the tenth century.—K. N. **Dikshit**: Two Harsola copper-plate grants of the Paramara Sikaya (II.), V.S. 1005.—Amareshvar **Thakur**: Jail administration in ancient India. A brief review, mainly based on data furnished by the Buddhist Jātakas and Kautilya's Arthasāstra, drawing the conclusion that a humane element was not wanting in ancient Indian criminal justice.—Sir Gilbert T. **Walker**: A note on Indian boomerangs. Description, with illustration, of a new species, called *Kâtar*, used as a throwing stick by the Bhils.—Paul **Tedesco**: The dialectical position of Ormurī.—N. G. **Majumdar**: A list of Kharosthī inscriptions.—H. Srinivasa **Rao**: Note on a brackish-water actinian from Madras. A form apparently new to science, probably closely allied to *Pelocoetes*, which was collected in 1922, was described.—H. **Chaudhuri**: *Oedogonium Nagii sp. nov.* Found at Lahore, developing in a bottle containing a collection of Zygnemas.

OTTAWA.

Royal Society of Canada (Section V., Biological Sciences), May 19-22 (Annual Meeting at Quebec).—F. C. **Harrison** (Presidential Address): Historical review of the red discoloration of foodstuffs.—A. H. Reginald **Buller**: (1) Luminous leaves; (2) *Sphærobolus stellatus* and the dispersion of its spores by herbivorous animals.—C. W. **Lowe**: The fresh-water algæ of Central Canada.—B. T. **Dickson** and G. A. **Scott**: Identity of the organism causing black-dot disease of the potato, Part I. and Part II.—B. T. **Dickson** and W. L. **Gordon**: The effect of various smut control treatments on the germination of oats.—C. D. **Kelly**: The bacteriology of the Kingston cheese.—N. S. **Golding**: A study of the moulds in blue-veined cheese.—A. G. **Lochhead**: (1) Microbiological relationships in frozen soils; (2) Psychrophilic soil bacteria.—G. W. **Scarth**: The toxic action of distilled water and the antagonism to it of cations.—A. B. **Macallum**: The origin of karyokinesis.—A. T. **Cameron** and J. **Carmichael**: After-effects of feeding thyroid to young rats.—A. T. **Cameron**: (1) The action of absorbable intestinal toxins on metabolism; (2) The cranio-facial axis of Huxley—Pt. I., Embryological considerations.—J. G. **FitzGerald** and Dorothy G. **Doyle**: A further study of the question of utilisation ("fermentation") of saccharose by *B. diphtheriæ*.—J. J. R. **Macleod**, J. **Hepburn**, J. K. **Latchford**, and N. A. **McCormick**: The effect of insulin on the percentage of sugar in blood from different regions of the body.—J. J. R. **Macleod**, E. C. **Noble**, and M. K. **O'Brien**: The influence of insulin on the glycogen content of the liver and muscles during hyperglycæmia.—G. S. **Eadie**, J. J. R. **Macleod**, and M. D. **Orr**: The soluble carbohydrates of liver and muscle and the influence of insulin on them.—F. N. **Allan** and S. S. **Sokhey**: Further observations on depancreatised animals.—S. U. **Page**: The effect of insulin on chloridzin diabetes in dogs.—J. **Markowitz**: The behaviour of the diastases in diabetic animals treated with insulin.—Frederick R. **Miller** and H. M. **Simpson**: Viscero-motor reflexes.—R. **Miller** and R. A. **Waud**: Pulse and cardiac records obtained with electropolygraph.—G. A. **Ramsay**: Amplification of heart sounds by radio apparatus.—J. **Miller**: Classification of tumours arising from the trophoblast, with illustrative cases.—C. McLean **Fraser**: *Acaulis Primarius*, Stimpson.—A. G. **Huntsman**: Some results of the Belle Isle Strait Expedition, 1923.—R. H. **McGonigle**: The distribution of pile borers on the Canadian Atlantic coast.—A. H. **Leim**: Certain features in the life-history of the shad.—A. G. **Huntsman** and M. I. **Sparks**: Resistance of marine animals to high temperatures, and their distribution in Nature.—C. H. **O'Donoghue**: A list of the Nudibranchiate Mollusca recorded from the Pacific coast of North America, with a note on their distribution.

VIENNA.

Academy of Sciences, January 10.—Kurt **Ehrenberg**: On the development of the base of the skull in cave bears from the Drachenhöhle near Mixnitz. The communication is chiefly concerned with the confirmation of a hitherto unobserved epiphysis formation in the lower half of the posterior head condyles of the cave bear (*Ursus spelaeus*), which appears during the second year of life. Later the epiphysis fuses completely with the original condylus occipitalis. Its formation is conditioned by a change in the attitude of the skull, a downward inclination of the skull as it becomes heavier, and appears to have arisen only in the males.—A. **Skrabal** and H. **Airoldi**: On the rate of hydrolysis of ethyl ether.—A. **Skrabal** and M. **Baltadschiewa**: On the rate of hydrolysis of orthoacetic-ethyl ether.—R. **Andreash**: Note on the paraban acids.—R. **Andreasch**: On the carbamide and guanidin derivatives of the sulphur-substituted fatty acids; Part II.—E. **Müller**: On combined conic sections of conic section pencils.—K. **Ehrenberg**: On the development of the anterior region of the skull of the cave-bear from the Drachenhöhle near Mixnitz.—A. **Pisek**: The development of the anthers and the meiotic division of the pollen mother cells in the juniper-mistletoe, *Arcenthobium Oxycedri*; the structure of the anthers and the number of chromosomes in the cells of *Loranthus europæus*. The anther of Arcenthobium is regarded as equivalent to a microsporangium. The meiotic division of the pollen mother-cells sometimes shows disturbances caused by insufficient nourishment of the parasite by the host plant.—R. **Kreman**, R. **Kienzl**, and R. **Markl**: Electrolytic conduction in fused alloys; Part III., The electrolysis of lead-cadmium and of lead-sodium-cadmium alloys. With currents of about 1 amp. per sq. mm., an increase in the concentration of lead was found to occur at the anode and of cadmium or sodium respectively at the cathode.

January 17.—R. **Kreman**, R. **Müller**, and H. **Kienzl**: Electrolytic conduction in fused alloys; Part IV., The electrolysis of mercury-sodium alloys. The increase in concentration of sodium at the cathode and of mercury at the anode was found to grow with the density of the current to a maximum of about 9 per cent.—R. **Kreman**, R. **Müller**, and R. **Ortner**: Electrolytic conduction in fused alloys: Part V., The electrolysis of mercury alloyed with potassium, calcium, and cadmium. An increase in the concentration of potassium, calcium, and cadmium is observed near the anode, the effect increasing with the density of the current.—L. **Moser** and A. **Brukl**: On solid compounds of hydrogen and arsenic. The formation of solid As_2H_2 according to Reckleber and Scheiber is confirmed. A new solid compound, tetra-arsenic hydride As_4H_2 was obtained by the use of weak oxidising agents on gaseous AsH_3.—K. **Schnarf**:

Remarks on the position of the genus Saurania.—K. **Keissler**: Fungi novi Sinenses a H. Handel Mazzetti lecti II.

January 24.—H. **Micoletzky**: Final report on free-living nematodes from Suez. The Mediterranean and the Red Sea appear to have more nematodes in common than the Mediterranean and the North Sea.—G. **Götzinger**: Morphological studies after the great landslide of the Gras-mountain at Oberwang in Attergau.—H. **Handel-Mazzetti**: Plantæ novæ Sinenses diagnosibus brevibus descriptæ.

February 7.—F. **Werner**: New or little known snakes from the State Museum of Natural History at Vienna. New genera of aglyptic Colubrides, *Procteria viridis* (n. sp.), South-west Africa, allied to *Pseudoxenodon*, *Pachyophis temporalis* (n. sp.), *Triænopholis arenarius* (n. sp.), *Aryrogena rostrata* (n. sp.), Argentine, *M. elegantissima* (n. sp.), *Pseudoromacer lugubris* (n. sp.), San Paolo, Brazil, *Nerophidion hypsirhinoides* (n. sp.), allied to *hydræthiops*, *Padangia pulchra* (n. sp.), Padang, Sumatra, *Eoninophis lineolata* (n. sp.), East Africa.—A. **Skrabal** and M. **Baltadschiewa**: On the rate of hydrolysis of ortho-carboxyl-ethyl-ether.—A. **Skrabal** and A. **Matievic**: The dynamical equilibrium of malic ester.—E. **Schweidler**: Studies in atmospheric electricity, No. 65, On the characteristics of the current in slightly ionised gases. The characteristic of the ions is calculated by linear recombination law and the proportionality between conductivity and the saturation deficit of the current is found to hold. The term semisaturation potential (corresponding to 50 per cent. saturation) is defined. The application to practical measurements is demonstrated.—W. **Schlenck**: Studies in atmospheric electricity, No. 66, Experimental investigations on the characteristic of the current in weakly ionised gases. With a cylindrical condenser as ionising vessel, the current-potential function was found to correspond to the linear law of recombination.—M. **Blau**: On the disintegration constant of radium A (Mitt d. Ra-Inst's No. 161). A new experimental determination gives the radioactive constant . . . $\lambda = 0{\cdot}2273 \pm 0{\cdot}0007\ \text{min}^{-1}$; the half value period was found to be $T = 3{\cdot}05 \pm 0{\cdot}009$ min.—W. **Riss**: On the composition of bröggerites and on the genetic relationship between thorium and uranium (Mitt. d. Ra-Inst's No. 162). A large number of analyses on bröggerites have proved that idiomorphic bröggerites are probably all (many of them without doubt) older than the lodes in which they are found. As there are also non-idiomorphic bröggerites, it remains an open question whether these can be used for age measurements and also whether the large differences in the ages of the lodes found in this way are real. The results do not contradict the assumption of a genetic relationship between thorium and uranium.—E. **Lohr**: On the comparison made by Fr. Schenner between the Jaumann's theory of gravitation and observations.—G. **Flumiani**: On a dimethyl - tetroxy - anthrachin. — K. **Brunner**, W. **Seeger**, S. **Dittrich**: Diacyamine.—A. **Tauber**: On the integration of linear differential equations, IV.—O. **Storch**: Studies on dragonflies from the biological station at Lunz, Lower Austria, and the second Zoological Institute of the University of Vienna. *Somatochlora metallica*, an anisopterate odonate, lays its eggs in the earth inserting its ovipositor in the intervals of its flights over water. The Odonata anisoptera are not gliding air-machines; they make the best use of the freedom of movement which their mode of flight permits, lifting themselves straight into the air and performing all sorts of evolutions during oviposition.—F. M. **Exner**: On the release of cold and warm outbursts in the atmosphere.—F. **Feigl**: Contributions to the study of the relationship between the grouping of atoms and specific affinity, Part I.

February 17.—P. **Weiss**: (1) Regeneration o whole from half the cut surface of an extremi *Triton cristatus* (from the Institute of E mental Biology of the Academy of Science, Vie If the leg be split and both parts shortened by am tion, a whole foot will regenerate from the ha surface when the second half regenerates notl otherwise regeneration of a whole foot occurs, di between the two stumps, forming a split extremi merging into one blastema. (2) Regeneration fr double cut surface of an extremity in *Triton cris* When the arm is artificially bent in such a way the radius lies parallel to the humerus, fixed in a position, and the elbow cut off, exposing tw surfaces, one from the humerus, one from the arm, a symmetrical structure regenerates, the reg ating part from one cut surface being the mirror i of the other.—I. **Sciacchitano**: The stage in dopa is formed in the cocoon of the moth *Lop pini* (from the Institute for Experimental Biolo the Academy of Science, Vienna). Dopa, *i.e.* d phenyl-alanin, is only produced in the cater during spinning and is already lost when the st pupation is attained.—L. **Kober**: Contribution t geology of anomalies in the gravitational fo A. **Köhler**: Petrographic-geologic observations i south-western forest district.—L. **Kölbl**: Report petrographic-geological studies in the western p the forest district in Lower Austria.—L. **Waldm** Preliminary report from the survey of the Mor district to the south of the Eggenberg-Siegsmun berg railway line.

February 21.—A. **Skrabal**, F. **Pfaff**, and H. **Ai** On saponification of keto-carbonic-ester.—H. **Lie** D. **Schwarzl**: On elemic acid from Manila elemi-

Official Publications Received.

Bulletin of the American Museum of Natural History. Vol. 51, Miocene Oreodonts in the American Museum. By F. B. Loomi 37. (New York City.)

University of Illinois Engineering Experiment Station. Circu 11: The Oiling of Earth Roads. By Prof. Wilbur M. Wilson. (Urbana, Ill.) 15 cents.

Colony of Southern Rhodesia. Report of the Director of Vet Research for the Year 1923. Pp. 8. (Salisbury, S. Rhodesia: (ment Printer.)

Memoirs of the Department of Agriculture in India. Botanical Vol. 13, No. 2: The Wilt Disease of Safflower. By S. D. Josh 39-46+3 plates. (Calcutta: Thacker, Spink and Co.; Londo Thacker and Co.) 1 rupee; 1s. 6d.

Smithsonian Institution: United States National Museum tributions from the United States National Herbarium. Vol. 24, Economic Fruit-bearing Plants of Ecuador. By Wilson Popeno x+101-134+plates 34-49. (Washington: Government Printing 15 cents.

The South African Journal of Science. Vol. 20, No. 2, Decembe Comprising the Report of the Twenty-first Annual Meeting of th African Association for the Advancement of Science, Bloemf 1923, July 9-14. Pp. iv+285-604. (Johannesburg.) 15s. net.

Experimental and Research Station, Nursery and Market Industries' Development Society, Ltd., Turner's Hill, Cheshunt, Ninth Annual Report, 1923. Pp. 97. (Cheshunt, Herts.)

Proceedings of the Royal Society of Edinburgh, Session 1923–192 44, Part 2, No. 15: An Investigation into the Structure and Life-l of the Sulphur Bacteria (I.). By Dr. David Ellis. Pp. 153-167. burgh: R. Grant and Son; London: Williams and Norgate.) 1s.

The Organization, Achievements and Present Work of the Do Experimental Farms. Pp. 302. (Ottawa: Government Printing B

National Association of Master Bakers, Confectioners and Ca Reports on Research at the National Bakery School, London, con by Dr. C. Dorée and John Kirkland. Pp. 26. (London: 89 Kir W.C.2.) 2s. 6d.

Department of the Interior: Bureau of Education. Bulletir No. 58: Statistics of Kindergartens 1921–22. Prepared by the Sta Division of the Bureau of Education under the Direction of Fr Phillips. Pp. 7. (Washington: Government Printing Office.) 5

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Ministère de l'Instruction publique et des Beaux-Arts. Enqu documents relatifs à l'enseignement supérieur. 119: Rapports observatoires astronomiques de Province, année 1923. Pp. 129. Imprimerie Nationale.)

Rapport annuel sur l'état de l'Observatoire de Paris pour l'ann présenté au Conseil dans sa séance du 14 février 1924. Par M. B. B Pp. 43. (Paris: Imprimerie Nationale.)

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number : GERRARD 8830.
Telegraphic Address : PHUSIS WESTRAND, LONDON.

NO. 2858, VOL. 114]

Science and Life.[1]

THERE has been no niggardliness in the intellectual menu provided for the Toronto visit of the British Association. There is plenty to masticate, and there are also delicacies. But the metaphor is dangerous, and we let it drop. The president, Sir David Bruce, strikes the humane note, "Science for Life," in his fine address. In the long run, man wins against microbe ; thus Malta, once the most deadly of foreign stations, becomes a health resort ; Malta fever is beaten in the first round. Anti-typhoid inoculation was one of the outstanding victories of the war, and the anti-toxin treatment of tetanus was another. The prevention of tuberculosis depends fundamentally on improved environment and on the education of the people in the art of health. The protozoal infectious diseases, like the bacterial, are being mastered—witness sleeping sickness and malaria. Successful attacks are being made on the undetermined group of infectious diseases, probably due to "filter-passer" germs, such as trench fever and typhus fever. Here the zoologists have to be thanked for their discovery and tracking of the insect and mite carriers ; and what shall we say of the attacks on deficiency diseases, whether the standard of victory bears the legend "vitamins," "balanced nutrition," or "endocrine glands"? "Man has come into his heritage."

Prof. J. W. Gregory, addressing the Geography Section, brings us back to the idea of "Control." He seeks to show that, if due care be taken, the white man is not physiologically disqualified from manual labour in the tropics. This simplifies inter-racial problems, as it provides an additional outlet and a spacious home for the European race. The world has reached its present position by help of each of the three great races, and it still needs the special qualities of each of them—the contemplative Asiatic, who founded religions ; the artistic Negro, who probably gave the world the gift of iron, and the administrative European, who has organised the brain power of the world. But "the affectionate, emotional Negro, the docile, diligent Asiatic, and the inventive, enterprising European do not work at their best when associated in mass." Individual association there must be, but co-residence *in mass*—that way lies trouble. But will the clock stand the implied turning back of its hands, and will our hygienically resolute swarming into the tropics stop short of being massive ?

In his careful address to the Anthropology Section, on health and physique through the centuries, Dr. F. C. Shrubaill showed that Britain is *not* going to the dogs. "A pessimistic view of the physical or mental condition of the people of England is unnecessary and unfounded." Stature and weight are not less than in the days of Agincourt ; the general health of the nation is better and the expectation of life longer than ever before ; the real increase of the unfit is much less than has been assumed on a priori arguments ; the dysgenic tendencies of industrialism are being successfully opposed. Not that Dr. Shrubsall is satisfied with things as they are. His thesis, well documented, is

[1] The Advancement of Science, 1924 : Addresses delivered at the Annual Meeting of the British Association for the Advancement of Science (94th Year), Toronto, August 1924. Pp. iv+33+19+36+20+16+24+30+12+21+15+7+14+9+14. (London : British Association, 1924.) 6s.

that they are not nearly so bad as some Cassandras make out.

An inspiring address to the Physiology Section by Dr. H. H. Dale dealt with the progress and prospects of chemotherapy. "Science for Life" again! Chemotherapy in general is the specific treatment of infections by artificial remedies, but Dr. Dale was picturing the systematic chemotherapy which the genius of Ehrlich revealed, "the production by syntheses of substances with a powerful specific affinity for, and a consequent toxic action on, the protoplasm of the parasites, and none for that of the host." What Ehrlich was in search of were introduceable substances, which, as he said, should be maximally parasitotropic and minimally organotropic. What makes the difference is a biochemical problem still unsolved, but contributions to the reading of the riddle are rising above the horizon.

"As the biological complexity of the problem is realised, it becomes increasingly a matter for wonder and admiration that so much of practical value has already been achieved—the treatment of the spirochætal infections, syphilis, yaws, and relapsing fever, revolutionised; Leishmania infections, kala-azar and Baghdad boil, and Bilharzia infections, which crippled the health of whole populations in countries such as Egypt, now made definitely curable; trypanosome infections, such as the deadly African sleeping-sickness, after years of alternating promise and disappointment, brought now at last within the range of effective treatment."

Such achievements, we must remember, have rewarded experiment during a period—does it ever end?—when practice outran theory. What victories may be looked for when a fuller understanding affords not only tactics, but also strategy. This address will appeal to many very strongly with its Pisgah view of a Promised Land with no unconquered infectious diseases.

To the Botanical Section Prof. V. H. Blackman gave an address which does not sound like botany at all, it is so interesting. There is nothing in it about a "hortus siccus," and it is impossible not to be thrilled by the account of the unending attacks which the parasites make on the capitalists.

One of the peculiarities of parasitic diseases in plants, as contrasted with those of animals, is that the plant seems to give the same answer back to quite different invaders. Among animals, if certain symptoms appear, one can, in most cases, infer the presence of a certain parasite, but in plants a large number of infectious diseases display the same symptoms. This makes the practice of medicine among plants much more difficult than among animals. Another difference is that the acquired immunity due to one attack of a disease which is so common in animals is quite unknown in plants. Again, owing in part to the absence of a circulating blood-stream, the plant makes a local rather than a general reaction to the infectious disease.

Immunity and resistance to diseases are, of course, well known among plants, but they illustrate *natural*, not acquired immunity. There may be some physical barrier which resists the entry of the parasite, or the entry may call forth a wound reaction leading to the production of cork which checks further advance. This natural resistance may be increased by good cultivation, or Mendelian breeding may build up a plant synthetically which is resistant to various intruders, but there seems to be no hope of finding a way of endowing plants with artificial disease-resistance.

As Lord Kelvin was born a hundred years ago and as Faraday discovered the principle of the electromotor in 1821, it was very appropriate that Prof. G. W. O. Howe should address the Engineering Section on "A Hundred Years of Electrical Engineering." He told a story of fascinating interest—a story that mankind may well be proud of. It is a record of "the mastery of man over the resources of nature, and in the use of these resources to the amelioration of the conditions of life." Every one knows part of the story, but a general review is very eloquent.

"By the aid of electricity the energy of the coal of the lake or river a hundred or even two hundred miles away is transmitted noiselessly and invisibly to the city, to supply light and warmth, to cook the food, to drive the machinery, to operate the street-cars and railways." We flash intelligence to the most distant parts of the globe; we talk to our friends hundreds or even thousands of miles away; at small cost we can equip ourselves with what may almost be regarded in a new sense. "Whereas thirty years ago a ship at sea was completely isolated from the life and thought of the world, it is now in continuous communication with the land and with every other ship within a wide range."

In no branch of electrical engineering is there any suggestion of having reached a limit; rapid development is taking place in every direction.

Prof. William McDougall spoke of "Purposive Striving as a Fundamental Category of Psychology." The life of man from birth to death is one long series of purposive strivings. Even in his dreams the striving goes on. This must be recognised as an all-important aspect, corrective to the picture of man as "a bundle of mechanical reflexes, a superior penny-in-the-slot machine, whose workings are mysteriously accompanied by various 'elements of consciousness.'" The address may be described as a plea for more courage in psychology, which is spoken of as "the most concrete of the sciences."

Three of the addresses of presidents of Sections will not be delivered until Monday, August 11, so we cannot deal with them this week: they are by Sir William Bragg on the analysis of crystal structure by X-rays, by Prof. F. W. Gamble on construction and control in animal life, and by Sir John Russell on present-day problems in crop production. We are reluctantly forced to pass over here the other presidential addresses—by Sir Robert Robertson on chemistry and the State, by Prof. W. W. Watts on geology in the service of man, by Sir W. Ashley on Free Trade doctrine, and by Principal E. Barker on academic freedom in universities, but summaries of them will be found in the Supplement to this week's issue. They are as interesting and as important as those of which we have given glimpses, and Toronto cannot complain of having been offered "second best" material. There is a very high standard throughout. There is also an interesting unity, for most of the addresses come round to the fact that man conquers by understanding. The people perish for lack of knowledge; but science is for life, even for the life that is more than meat.

Where Philosophy joins Forces with Mathematics.

Substance and Function and Einstein's Theory of Relativity. By Ernst Cassirer. Authorised translation by Dr. William Curtis Swabey and Dr. Marie Collins Swabey. Pp. xii+465. (Chicago and London: The Open Court Publishing Co., 1923.) 3·75 dollars.

THE translators of Prof. Ernst Cassirer's most important contributions to mathematico-logical theory have done well to issue his "Substanzbegriff und Fonktionsbegriff" and his "Zur Einsteinschen Relativitätstheorie" together in one volume, although a considerable time interval separates the two works. The first appeared in 1910, the second in 1921, and the interval covers the formulation by Einstein of the new theory of gravitation. By presenting the two together, the philosophical significance of the principle of relativity and the intimate connexion of its mathematico-physical form with the logico-epistemological form of the philosophical problem are clearly brought out. The translation has succeeded in reproducing the clear scientific expression of the German and reads like an original English work. For an American publication there are singularly few Americanisms in the text. It is very unfortunate, however, that the word "Begriff" is not retained in the English title. The book is not about substance and function but about the concept; substance and function are meant to be adjectival, not substantival terms.

Prof. James Ward, in his recent most illuminating work, "A Study of Kant," has shown very clearly how Kant's interest in natural science and desire to discover its metaphysical basis were the original motive and directing force of his philosophy. Prof. Cassirer enables us to see the real significance of the Kantian doctrine in its relation to physical theory. The transcendental æsthetic was not, as often represented, a subjective idealism in regard to the concepts of space and time; on the contrary, it was a justification of the objective use of those concepts and intended to rationalise the Newtonian doctrine and provide a philosophical basis for the Newtonian physics. The attempt of Kant in the transcendental analytic to provide the necessary scientific categories is still more striking. It is curious to follow the complete transformation which has overtaken the chief doctrines of formal logic since he took it as the type of the perfect science, the science which since Aristotle had not had to advance or retrace a single step. This is Prof. Cassirer's starting-point. He shows how the Aristotelian logic depends on the Aristotelian metaphysics, how this accepts the substantival aspect of the world as given fact and the work of thought as discovery, and he traces the steps and stages by which in modern mathematical and logical theory, since Kant (and even before Kant, for the essential change of direction is found in Descartes and Leibniz), the whole position has been reversed.

The fundamental thought of logical idealism is most strikingly exhibited in mathematical theory. "More and more the tendency of modern mathematics is to subordinate the 'given' elements as such and to allow them no influence on the general form of proof." The concept of magnitude gives place to the concept of function; quality, not quantity, is the real foundation of mathematics. In place of the analysis of parts there appears the resolution into concepts.

How do we form concepts, and what purpose do they serve? The two questions are really one, the fundamental problem of the nature of the physical world which is the basis of physical science. Two principles seem equally insistent. One holds us firmly to concrete experience. The concept seems empty and meaningless which does not deepen and enrich our intuition. Yet when we turn to the mathematical concepts, and especially to the meaning of number, we seem to grasp this meaning completely only when thought has freed itself from seeking in concrete experience a correlative for its constructions. We are left to choose between two views of the world: either the empirical view that the only existent is what we can point to as an individual in a real presentation, or the idealist view that what really exist are intellectual structures which can never themselves be presented. Mathematics will not solve the riddle. All it can do is to lay bare the ultimate intellectual roots of our analysis of experience.

What then is the relation of mathematics to physics? The advance of theoretical physics has completely superseded the old view that measurements inhere in physical things and are just read off. The intellectual work of understanding a bare fact presented in sense-experience as an entity or empirical object only begins when the fact is replaced by a mathematical symbol. For the physicist the individual thing is a system of physical concepts. To distinguish one object from another, he must subsume it under a conceptual class. He analyses the object into the totality of its numerical constants; he does not break it up into the group of its sensuous properties. The thing changes from a sum of properties into a mathematical system of values established with reference to a scale of comparison. The constitutive parts of

the perception are left completely out of account, and the mathematical symbol which constitutes the object a member of a system is taken as the real kernel of empirical reality. It is only when we bring the given under some norm of measurement that it gains fixed shape and form and has clearly defined properties. The metaphysical concept of substance, which natural science always clung to, has been displaced in the progress of science itself.

It is not possible to give more than an indication of the important contemporary work on methodology and philosophy of science which is surveyed and systematised in this book. Most students will probably turn first to what is described as a supplement, the essay on "Einstein's Theory of Relativity from the Epistemological Standpoint." The value of this essay is enhanced by the fact that Einstein himself read it in manuscript and gave the author the benefit of his criticisms. It is, Prof. Cassirer tells us, at first sight somewhat strange and paradoxical that such diverse epistemological points of view as those of radical empiricism, positivism, and critical idealism should all have appealed to the theory of relativity in support of their fundamental views. The reason is that they all appeal to experience and they all teach that every exact measurement presupposes universal empirical laws. The real problem is how we reach those laws and what sort of validity we grant them. For positivism they are grounded in sensation and never go beyond its domain; for idealism all equations are results of measurement. We neither measure mere sensations nor do we measure with mere sensations; relations of measurements transcend the given and replace perception with a conceptual symbol. The typical example is the development of modern physics in the theory of relativity.

A quotation better than any description will give an insight into the author's own philosophical point of view:

"Only the idealistic concept of truth overcomes finally the conception which makes knowledge a copying, whether of absolute things or of immediately given 'impressions.' The 'truth' of knowledge changes from a mere pictorial to a pure functional expression. In the history of modern philosophy and logic, this change is first represented in complete clarity by Leibniz, although in his case the new thought appears in the setting of a metaphysical system, in the language of the monadological scheme of the world. Each monad is, with all its contents, a completely enclosed world, which copies or mirrors no outer being but merely includes and governs by its own law the whole of its presentations; but these different individual worlds express, nevertheless, a common universe and a common truth."

H. WILDON CARR.

The Cheyenne Indians.

The Cheyenne Indians: their History and Ways of Life. By G. B. Grinnell. Vol. 1. Pp. ix+35[illegible] 23 plates. Vol. 2. Pp. vii+430+25 plates. (New Haven: Yale University Press; London: Oxford University Press, 1923.) 45*s.* net.

MR. GRINNELL has spent some time each y[illegible] with the Cheyenne Indians ever since 18[illegible] and in this way he has come to know them as [illegible] others can have done. As he says himself:

"I have never been able to regard the Indian a[illegible] mere object for study—a museum specimen. A h[illegible] century spent in rubbing shoulders with them, dur[illegible] which I have had a share in almost every phase [illegible] their old-time life, forbids me to think of th[illegible] except as acquaintances, comrades, and friend[illegible] Yet he can say, "I am constantly impressed [illegible] the number of things about the Indians that I [illegible] not know."

He has embodied the results of his study in t[illegible] large and interesting volumes, which deal with [illegible] aspects of the life of this tribe, and it may come [illegible] a surprise to many to realise how much of the old [illegible] still exists. Mrs. Grinnell and Mrs. J. E. Tuell h[illegible] enriched the book with numerous photographs of [illegible] people, their ceremonies and games, their everyd[illegible] implements and utensils.

The Cheyenne are one of the tribes of the Algonqu[illegible] family; to-day they are divided into the North[illegible] Cheyenne in Montana and the Southern in Oklahor[illegible] and in 1921 they numbered about 3281. They [illegible] themselves Tsistsistas, which probably means "[illegible] people," "those related to us," though the Rev. [illegible] Petter has suggested that it means "cut" or "gashe[illegible] people, from the sign by which they used to design[illegible] themselves. Their movements can be traced back [illegible] about 200 years, but the tales of their origin are, [illegible] G. A. Dorsey also says, rather tales of early migrat[illegible] than of origin. They seem to have come from t[illegible] north-east or east, but from how far north it is i[illegible] possible to discover, possibly from a region north [illegible] the great lakes and toward Hudson Bay, as th[illegible] legends tell of crossing a great lake much in t[illegible] manner of the Israelites under Moses.

The old-time lodges were made of willow sho[illegible] plastered over with clay for the winter, but in summ[illegible] their lodges were woven of peeled and unpeeled will[illegible] stems arranged to make a pattern, and unplaster[illegible] Their present lodges are made of skins, probab[illegible] developed from the wind-breaks of undressed hides [illegible] a framework of poles which they used to set up.

Among methods of self-torture described in t[illegible] chapter on camp customs is one which seems to be[illegible]

certain resemblances to the hook-swinging formerly practised in some parts of India. Dorsey mentions the same form of torture as having been performed in 1903 in connexion with the Sun Dance, but Grinnell says that though it might be done at the time of the Medicine Lodge, it might be done at any time in fulfilment of a vow. Strips of skin were often removed as a sacrifice well-pleasing to the Great Medicine, or Great Spirit, thus leaving scars all over the body.

The Cheyenne are organised into ten groups or divisions, and from the testimony of several of the most aged men, Mr. Grinnell has gathered much evidence of exogamy. Descent was matrilineal, and on marriage a man went to live with his wife's group. If a man deserted his wife, she and her children were cared for by her own group. Each group had its own special ceremonies and taboos, but these old practices have now long passed out of use and cannot easily be reconstructed. So difficult is it that the author says that present-day investigation would lead to the conclusion that tribal descent is in the male line, while up to twenty or twenty-five years ago the old men all agreed that the children belonged to the mother's group. Detailed inquiry into more than fifty marriages of old people, however, resulted in establishing the fact that the man and woman had in all cases belonged to different groups.

The author draws a delightful picture of the home life of the Cheyenne, giving an account of the natural daily round from childhood to death.

The second volume is mainly concerned with the war customs and great ceremonies and dances of the Cheyenne. There are seven soldier bands, mostly named after some animal; but not every strong and able-bodied man is necessarily a member of one of these bands. These bands form a kind of standing army and enforce the commands of the chiefs. To each band belonged four young women, chosen from the best families in the camp. Their duty was to be present at the meetings of the band, to take part in the singing and dancing, and sometimes to do the cooking. It was an honourable position; but though it was looked on as a kind of profession, no girl was obliged to remain in the band against her will; she generally resigned on marriage, though sometimes a married woman was chosen. There was also a curious institution called Contraries, usually two or three Contraries in each tribe, who acted and spoke in the reverse or opposite way to that of common usage. They had serious duties to perform, and might not mix on equal or familiar terms with the rest of the tribe; each had to "walk by himself," lest those treading in his tracks should meet with evil results. One of the chief duties of a Contrary seems to have been to protect his tribe from thunder, and to do this he carried a peculiar form of bow called a thunder-bow. He could only be relieved of office if some one asked for his bow, or if he lost it by any accidental means.

There is also a Contrary Society, the members of which, though they seem to have no connexion with the Contrary warrior with the thunder-bow, also act by contraries and are in some way connected with thunder. The members are mostly old men and women, and appear to be buffoons, but at the same time they are believed to be able to help the sick. In the Massaum Ceremony (Crazy or Animal Dance), which is fully described, the Contrary Society plays the part of the hunters who pretend to kill the animals represented by other actors in the ceremony. This Massaum Ceremony is an ancient rite and seems originally to have been performed in order to increase the supply of food in the camps. It takes place when any man makes a vow to perform it in order to obtain some benefit for himself, but at the same time it benefits all the community. It lasts for five days.

A detailed account is also given of the Medicine Lodge, the midsummer or summer ceremony of many Plains Indians, which was fully described by G. A. Dorsey in 1905 in the Field Columbian Museum Publication 99, as a part of his studies on the Sun Dance of the various tribes. This term, however, comes from the Sioux, and refers to one part only of the Cheyenne ceremony, which now lasts three, but formerly eight, days. This ceremony, too, is offered as a sacrifice by one or more members of the community. It was at this ceremony that the self-torture often took place.

Though the Indians are repeatedly said to be very religious, there seems to be no official priesthood; but for these great ceremonies there are special "instructors," who take the part of priests or masters of ceremonies.

As may be seen from this résumé of some of the contents, the book is full of interest, and it is written in a simple straightforward style which makes the reader feel all the time that the subject is dealt with by one who is intimately acquainted with the matter in hand. It is a most valuable and sympathetic study of a people whose old customs are still in a measure retained, though obviously breaking down under modern conditions, and thus it is well to have these things recorded before more is forgotten. As it is, the author is frequently obliged to confess that in some cases the meaning of certain ceremonies appears to have been lost.

A. C. HADDON.

Our Bookshelf.

Wood-fibres of some Australian Timbers: Investigated in reference to their Prospective Value for Paper-pulp Production. By Richard T. Baker and Henry G. Smith. Pp. 159. (Sydney: Alfred J. Kent, 1924.) n.p.

DURING the War the Australian people suffered much inconvenience from the deficient supply and high price of paper and paper-making materials, which could be procured only by importation from Europe and North America. This directed attention to the possibilities of the manufacture of wood-pulp at a cheap rate in the Australian forests; and during recent years some investigations have been carried out by the different governments of the Commonwealth. A short account of the nature and results of these inquiries is given in the introductory part of this book; and it is apparent that there is no lack of suitable kinds of timber. Sites for pulp mills can be found in certain forest districts where an abundance of pure water is available, an essential requirement for commercial success.

The main part of the work is devoted to a detailed study of sixty species of trees, as regards both the microscopic structure of the wood-fibres and the bleaching and felting properties of the separated fibrous material. Each description is accompanied by a photomicrographic illustration. Most of the species of Eucalyptus are of little value for paper-making owing to the shortness of their fibres; but the so-called "ashes," which constitute one section of this large genus, have long and flexible fibres, and are considered to be very promising for the production of "chemical" wood-pulp. The only conifer studied, *Araucaria Cunninghamii*, is suitable for the same purpose, and "sulphate" pulp is manufactured from it on a commercial scale at Yarraman Creek in Queensland.

The Control of the Speed and Power Factor of Induction Motors. By Dr. Miles Walker. Pp. 151. (London: Ernest Benn, Ltd., 1924.) 18*s*. 6*d*. net.

IN recent years the use of the three-phase system of distributing electric power has been rapidly extending. The great advances made in the methods of controlling economically the speed of induction motors are not known to many engineers. It is necessary, in order that they may choose the best kinds of motor for their every-day work both from the points of view of ease of control and of economy, that they should be able to study for themselves their relative advantages and disadvantages. We therefore welcome this book by one of the leading authorities on the subject.

In Chapter i. the author gives a sketch of the fundamental theory. He lays stress on the importance of the mathematical method of inversion as this leads to a simple method of proving the "circle" diagram. We are sorry that no proof is given of the geometrical theorems of inversion, as students may have difficulty in proving these for themselves.

A very full description is given of the methods of controlling the speed of an induction motor. In battleships two speeds are desired, one for cruising and one for "fighting." In the latter case the highest attainable speed is wanted. The fighting speed is usually about 50 per cent. greater than the cruising speed and requires about 3·5 times as much power. In the United States, where many ships have been fitted for electric propulsion, the method of pole changing is the one generally adopted. In the later chapters of the book, brief descriptions are given of the cascade motor and the frequency converter. A good description is given of the phase advancer designed by Gisbert Kapp.

Silent Highways of the Jungle: being the Adventures of an Explorer in the Andes and along the Upper Reaches of the Amazon. By G. M. Dyott. Second edition. Pp. 320 + 16 plates. (London: Chapman and Dodd, Ltd., 1924.) 7*s*. 6*d*. net.

THE interest of this book is more adventurous than scientific, but it is most readable and the pages are seldom dull. The author was commissioned by the Peruvian Government to investigate the possibility of aerial routes between the Pacific littoral and that isolated part of Peru which lies around the head streams of the Amazon. With this end in view, he made a journey overland from the port of Pacasmayo through the Andes by Cajamarca and Moyobamba to Yurimaguas and down the Huallaga and Marañon to Iquitos. This was a relatively easy task: the return by a more northern and partly unknown route was difficult. In the forests of the upper Marañon, Mr. Dyott was basely deserted by his carriers and left to his own resources in a trackless wilderness. At his last gasp he fell in with forest Indians, by whom he was held a virtual prisoner for some weeks before he got away and returned to the coast. The book describes vividly the conditions of travel in those remote regions, and has a good deal of information about rubber and agricultural possibilities, but its chief value lies in the account of the Aguavuna Indians. Existing maps were found to be faulty, but Mr. Dyott had no means of making new ones.

Physiotherapy Technic: a Manual of Applied Physics. By Dr. C. M. Sampson. Pp. 443. (London: H. Kimpton, 1923.) 30*s*. net.

MAJOR SAMPSON defines physiotherapy as "the use of physical remedies in the treatment of disease or disability," and classifies these remedies as thermal, chemical, mechanical, and electronic. Of the value of such methods of treatment there can be no doubt, but the author of "Physiotherapy Technic" has certainly not justified his claim that physiotherapy is destined to be the salvation of therapy. The main defect in this book is the very loose style of thinking and construction which it indicates. For the description of one technique we are referred to "Treatment of Optic Neuritis," but have failed to find the reference. The statement that "things not equal to the same thing are not equal to each other" is absurd, but its appearance as an argument in a scientific text-book is worse than absurd.

Major Sampson's experience entitles him to speak with authority on the methods of application of physical remedies, but the scientific reader will probably tire of the effort to discover what these methods are.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Sex Change and Breeding in the Native Oyster, *O. edulis*.

IN NATURE in 1922 (vol. 110, p. 212) it was shown that when an oyster spawns as a female it changes immediately into a male. In a later number of NATURE (vol. 110, p. 420) Spärck, who had been working on similar lines to the present writer, was able to confirm this observation. I have since continued similar observations on a large number of oysters with the same result, so that it can now be definitely stated as a fact that the female-functioning oyster normally changes into a male at about the period of the extrusion of ova; and further that the rapidity of the change strongly suggests the existence of a substance—which causes this change—in a fluid circulating in the body.

In the same number of NATURE I stated that experiments had been started to investigate the conditions of the reverse sex-change, that is, from male to female in both young and old oysters. The occurrence of this change has been suspected to occur on general grounds, but, so far as is known, has not been demonstrated. A brief summary of the results can now be given. In the summer of 1922, 115 oysters, which were proved to be male on a certain date by microscopic examination after boring a hole in the shell, were isolated in a cage in the sea along with 78 identified females. This experiment was a failure owing to an accumulation of mud in the experimental cage, and was repeated in July 1923 with 101 freshly determined males, and 28 fresh females, along with the remainder of the oysters the sex of which was known in 1922. By October 1923 nearly all the oysters had recovered, and most of them had put on good growth, but a sample of 18 oysters, which were male in July, were proved after a thorough examination to be either mostly feebly male or neuter sex. None of the oysters were in spawn at this time.

In June and July this year the oysters were again examined, with the following result at the instant of examination: of the 6 remaining individuals which were male in 1922, 50 per cent. had changed to females, and two of these were carrying recently extruded embryos; of the 69 remaining individuals proved to be male in 1923, only two extruded embryos at the time of examination; the rest are being kept intact in the sea to permit periodical examination for later spawning females.

Besides these proved male oysters, others which have spawned as females—which, as has now been established, would have changed immediately afterwards into males—have been also kept isolated in compartments of a cage in the sea. Of 16 remaining individuals female in 1922—and therefore by inference afterwards immediately male — 5 were female in July 1924, and 1 was carrying embryos at the time of examination; similarly, of 20 oysters female in 1923, and immediately afterwards male, 6 had changed into females in July 1924, and of these 2 were carrying embryos at the instant of examination.

The experiments described above were carried out at West Mersea on the East Coast, but similar results have also been obtained on the River Yealm on the South Coast. In the Yealm experiment some interesting cases occurred; for example, an oyster male in July 1922 was examined on July 9, 1923, and found to be still male, but nearly seven weeks later, on August 31, this same oyster was carrying an enormous number of fully developed shelled larvæ, and a few days later, on September 4, was rapidly developing sperm. This is an extremely interesting and important result, both theoretically and economically. In the same cage were 18 oysters, which were obtained from different parts of England; these had spawned as females in 1923, and afterwards changed immediately to males; of this group, 3 extruded numerous embryos in June to July this year, and were found by microscopic examination to have changed back again to males at once. It is expected that some of the remainder will have embryos during the next few months. Thus already 11 per cent. of these oysters have had at least *four experiences of sex in about a year*, reckoning from July to July, and this is believed to be the normal sequence of events in the European oyster for a good proportion of individuals which assume female characters in spring or early summer. It is, however, still an unsolved problem what proportion of individuals which are male in the spring change during the summer into females. So far I have only obtained one such case, but the reason would appear to be found in the difficulties of the work. It has been shown elsewhere that too much handling of oysters in summer causes "bleeding," and a loss of condition (Orton, "Fishery Investigations," vi. 3, 1923 (1924)), so that it is necessary to work continuously on or in close proximity to good oyster beds to obtain good results. Efforts are now being made to fulfil these conditions in further work.

In all the observations recorded above, it is to be noted that sex-conditions are only determined at the instant of examination, and as it is clear that sex-change does occur very rapidly, some sex-changes may have been missed. It is believed that in many cases changes of sex have been missed.

In the breeding of the oyster there are phenomena of a confusing nature which can only be referred to briefly here. It has been found that the mere dredging of oysters in the breeding season will cause those females which are ripe to spawn. I have called this phenomenon "forced spawning," and it has some peculiar results. The spawning female may extrude the whole or indeed any proportion of its ova. Now there are good reasons for believing that the act of spawning initiates the internal changes which result in changing the sex to male, and undoubtedly the sex-change does occur in females which have undergone forced spawning without expelling all their eggs. As a result the gonad in such cases would appear to the uninitiated to be hermaphrodite. Such individuals are, however, physiological males, and it has been shown elsewhere (*loc. cit.*) that the "residual" ova, as they have been termed, are absorbed, or dealt with in other ways. There is nevertheless a small proportion of hermaphrodite oysters which cannot be explained satisfactorily as physiological males, and since the act of spawning as a female may cause or is closely associated with the causes of the change to maleness, it is possible that stimuli, other than spawning, may produce a like result in a ripening female, and so produce a true hermaphrodite gonad.

Other explanations are, of course, possible; but the *proximal* cause of the change from male to female is still to be found. The change to female occurs commonly in the winter or early afterwards, but we have seen that it does also occur in the summer, though to an unknown extent; it is therefore apparently independent of seasonal conditions. An explanation which would satisfy those conditions would appear

to be as follows: at the birth of an oyster the conditions which determine sex result at first in the establishment of a functional male gonad (this statement is apparently true, but must not yet be regarded as having been definitely proved); at some time later, generally at the end of the winter or even during the summer, the predominance of internal male-determining conditions is lost, and female characters are assumed. At this stage the position is clear, for immediately the female character is lost, namely at spawning, the sex potentiality swings back to predominant maleness. It has been seen that the male condition can occur twice in one summer, but we have no evidence yet of the occurrence of femaleness twice in one summer.

Even if we assume that specific hormones are responsible in predominance for the condition of maleness and femaleness respectively, yet it would appear that some factor connected with external conditions is the cause for the assumption of femaleness. Can this be merely the accumulation of reserve products in a quantity sufficient to produce a crop of ova reacting on the general system of the organism after the male-determining mechanism, so to say, has run down? This condition might be an excess of glycogen in the body over that amount which can be stored, for example. A fact which lends some support to this view is that starved oysters are either feebly male or of neither sex. It is at this point that the study of sex-change appears to touch the all-important problem—for oyster-culture—of the "fishing-up" or natural fattening of oysters, on which subject there is still a great deal of work to be done. The investigations have been made partly by means of a grant from the Royal Society, and will be described in full on completion of the work in the Journal of the Marine Biological Association.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, July 23.

Relation between Pressure Shift, Temperature Class, and Spectral Terms.

IN a letter to NATURE of June 21, p. 889, I have shown the existence of a numerical relation between the pressure displacements of the lines of the iron spectrum, the temperature class of the lines, and the magnitude of the spectral terms which originate those lines by combination. It now seems probable that this relation is not only valid for iron, but may be a more general relation. Unfortunately, the available measures of temperature and pressure effects are neither very numerous nor very extensive, so that the general validity of the relation cannot at present be fully demonstrated. In a few cases, however, the available measures suffice to show that the relation holds very accurately.

The most complete data at present available are those for titanium. King (*Astroph. J.*, 39, 145, 1914, and 59, 1924) has studied the temperature effect; different authors have investigated the displacements by pressure, the results of Gale and Adams being the most extensive (*Astroph. J.*, 35, 1, 1912); C. C. Kiess and H. K. Kiess (Journ. Opt. Soc. Amer., 8, 607, 1924) have studied the structure of the spectrum of the neutral atom, and given the absolute values of the terms which form a great number of multiplets (quintets and triplets). Following the plan adopted for iron, the mean values of pressure shifts (taken from Gale and Adams) for multiplets of titanium have been plotted in Fig. 1 against the mean values of the sum of the terms forming each multiplet. The curve thus obtained is quite regular, and similar to that for iron, so that the two may be approximately superposed by a simple translation. Unfortunately, it is only possible to follow the curve for titanium up to displacement 0·20 cm.$^{-1}$; those lines which have appropriate terms to give displacements between 0·20 and 0·50 cm.$^{-1}$ are out of the range observed. In the tables of Gale and Adams there are some lines which show displacements greater than 0·50 cm.$^{-1}$, but they are not classified in multiplets.

Very recently, Laporte (*Zeit. für Phys.*, 23, 135, 1924) has made an estimate of the absolute values of the iron terms, giving 48,000 cm.$^{-1}$ for the term A, to which, in my first letter, the arbitrary value 60,000 cm.$^{-1}$ was assigned. In a future communication it will be shown that this value is a little too small. If the value 50,000 cm.$^{-1}$ be adopted, all the values of the remaining iron terms must be lowered by 10,000 cm.$^{-1}$, and the sum of two terms by 20,000 cm.$^{-1}$. When this correction is applied, the titanium curve superposes on the iron curve very closely, thus indicating that the relation for iron is not only of the same form for titanium, but also of the same order of magnitude.

The curves for iron and titanium show that the classification of lines in Classes I, II, . . ., may be

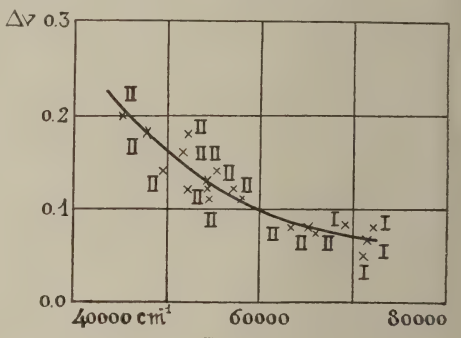

FIG. 1.

only a first approximation; the effect of temperature, like that of pressure, may be a continuous function of the sum of the terms. King remarks (*Astroph. J.*, 37, 264, 1913): "An examination of Table I. (referring to the classification of iron lines) shows a considerable variety as to the rate of growth among lines placed in the same class." In order to prove that the effect of temperature is as indicated by the curves for titanium and iron, I have examined in some detail all the spectra which have been investigated for multiplets and for temperature effects. In all cases the assumption has been quite confirmed. The details will be given elsewhere, but meanwhile the following examples will illustrate this point.

In the neutral iron spectrum there are several multiplets of Class I. If we arrange them in a list beginning with the multiplet for which the sum of its terms has the greatest value, and ending with that for which the sum has the smallest value, it will be noticed that we have at the same time arranged the multiplets beginning with the most sensitive at low temperature, and ending with the less sensitive. The greatest value for the sum of the terms is given in iron by the intercombination multiplet AE, of $n^5{}_3 - n^7{}_3$ (incompletely given by Walters, but now completed) in Paschen's notation, formed by the most sensitive lines of the iron temperature classification λλ5110, 5166, 5169, 5204, 5225, 5247, 5250, 5255; these lines, however, do not appear in King's furnace at 1400° because the sensitiveness of the film used was very poor beyond the blue. The relation of intensity of this multiplet AE in the arc and in the

rnace at low temperature is 1/1·2 ; multiplet AH, hich is situated in the middle part of the list of ass I multiplets, gives 1/1 for this relation, and ultiplet AJ, which is near the end of the list, gives o·2. So the sensitiveness of the multiplets at low mperature decreases gradually when the sum of he terms decreases.

It is interesting finally to remark that the iron tercombination multiplets AE, AZ, AX do not ppear reversed in spite of their being the most nsitive groups of this spectrum and combinations the ground level A. I think that it is not a rticularity of the iron spectrum, but a general ature of all intercombination lines. The resonance nes of magnesium, calcium, strontium, barium, and anganese, which are also intercombinations, are not und reversed. The titanium resonance lines, which ay be those of the intercombination multiplet $^4_4 - n^5_3$ (λλ5397, 5409, 5426, 5447, 5461), because ey give the greatest value for the sum of the terms this spectrum, are also found to be very sensitive, t not reversed.

M. A. CATALÁN.

Laboratorio de Investigaciones Físicas,
Madrid, July 1.

The Use of Naphthalene as a Fumigant in the Control of Red Spider and other Pests in Cucumber Houses.

A LETTER on "The Effect of Naphthalene Vapour n Red Spider Mite," signed by Mr. O. Owen and yself, appeared on pp. 280 and 281 (No. 2849, ol. 113) of NATURE on June 7.

Since that letter appeared, experiments have been rried out in distributing naphthalene in various ates of division over the beds in cucumber houses. he state of division was determined simply by assing pure commercial white flake naphthalene rough a graded series of sieves, ranging from 4 20 meshes to the inch ; "milled" naphthalene as also been used.

With naphthalene which has been passed through sieve of 16 meshes to the inch (=256 meshes to ne square inch) all stages of the red spider mite *Tetranychus telarius* L.), including the eggs, were illed in cucumber houses within a period of 24 ours, when the soil surface was at or above a emperature of 24° C. The amount of naphthalene sed was 3 lb. to every 100 feet of bed. Similar esults could only be obtained with naphthalene assed through a sieve of 8 meshes to the inch by sing double the weight of naphthalene, while owdered or milled naphthalene did not kill all the ider, and tended to produce scorching of the lants.

Experiments have shown that very finely divided aphthalene volatilises too quickly, and that the rge concentration of vapour resulting does not emain long enough in the atmosphere to kill all the ites. With milled naphthalene, on the other hand, he particles adhere so closely together that neither uitable distribution nor an adequate concentration f the vapours are obtainable.

When pure commercial white flake naphthalene as passed through a sieve of 16 meshes to the inch, nd broadcasted by hand at the rate of 3 lb. to every oo feet of border, no scorching of leaves or damage o plants resulted, provided that the plants were well atered before, and the atmosphere kept moist uring fumigation. Plants lacking water, however, ere often considerably scorched though not per-anently injured.

During fumigation the fruit is liable to taste slightly f naphthalene, so that it is inadvisable to cut fruit until the odour of naphthalene has disappeared from houses treated. If exposed to fresh air, the taste soon leaves the cucumbers.

Other pests liable to destruction by naphthalene fumigation in cucumber houses are wood-lice (species of Porcellio, and Armadillidium) and crickets. The fumigation has now been carried out on the commercial scale for cucumbers, and has proved effective in houses and blocks of houses ranging from 50 to 200 feet in length, and from 8 to 20 feet in height. It was found unnecessary to increase the amount of naphthalene in the higher houses.

In all cases the red spider mite has been killed without damage to the plants, by one fumigation, and a large proportion of the wood-lice have at any rate been destroyed.

EDWARD R. SPEYER.

Nursery and Market Garden Industries' Development Society, Ltd.,
Experimental and Research Station,
Cheshunt, Herts, July 22.

Oscillations in Vacuum Tube Discharges.

A LETTER from Profs. Karl T. Compton and Carl H. Eckhart appears in NATURE of July 12, in which reference is made to experiments on oscillations occurring in vacuum tube discharges functioning with the aid of a hot cathode.

I should like to be allowed to point out that, so far as I am aware, the first published notice of this effect was a paper of mine in the *Radio Review* (now the *Wireless World and Radio Review*) of November 1919.

The general explanation there offered of the phenomenon requires some modification, but it was clearly shown that in the particular case of mercury vapour, ionic oscillations of easily regulated frequency could be produced by merely altering the potential conditions of the tube.

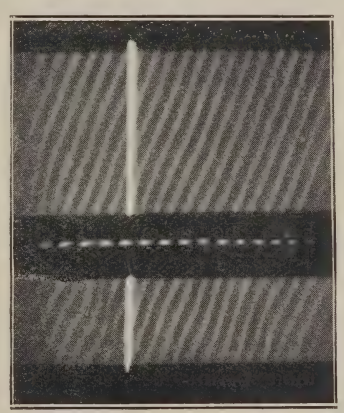

FIG. 1.

May I add that during the past year I have been following up these results in the particular case of vacuum tube discharges both with hot and cold cathodes with interesting results ? When the discharge obtained from a battery of accumulators is viewed in a rotating mirror, cases are found when the appearance presented by the photograph (Fig. 1) is the rule. (See Aston and Kikuchi, Proc. Roy. Soc., 1921.)

The inclined lines represent flashes of luminosity proceeding at a constant velocity away from the cathode, apparently moving at a rate which depends both on the gas pressure and on the applied potential.

The spectrum when examined by the Fabry and Perot étalon method does not exhibit, however, the Doppler effect.

These and other results will be presented and discussed in a paper now in course of preparation.

R. WHIDDINGTON.

Physics Laboratories,
The University, Leeds,
July 16.

Absorption Spectra of Some Metallic Vapours.

In the course of our experiments on the absorption of light by vapours of different metals, we have recently photographed the absorption spectra of lead, bismuth, antimony, thallium, and magnesium with the following results :

(1) The absorption spectrum of lead shows at 1100° C., besides the fundamental line 2833 and some other lines, a faint banded spectrum which has not been described previously. These bands extend from λ3000 to λ3320 Å.U. The interval between the various bands is nearly constant and is equal to 32 Å.U.

(2) The absorption spectrum of bismuth shows besides the "raie ultime" 3067, a typical banded spectrum containing about twenty bands. The absorption at each of these bands is very diffuse and complex, consisting of a number of fine bands. With increase of vapour density all the bands gradually fuse together (beginning from the short wave-length side) to form a region of continuous absorption.

(3) The absorption spectrum of antimony shows a fine line and a banded spectrum on the short wave-length side of this line, which has not been described previously. The fine line is at λ2310, and the bands extend from λ2304 to λ2200, with a constant interval of 15 Å.U. nearly. Eight of these bands have been photographed.

(4) A long column of non-luminous vapour of magnesium is found to absorb, besides the line 2852, λ4571, the single line spectrum of the element.

(5) The absorption spectrum of the non-luminous vapour of thallium shows at high temperatures, besides the lines of sharp and diffuse series, some prominent bands and lines due probably to Tl_2 molecules. A study of anomalous dispersion of the vapour by the method of Kundt's crossed prisms showed that at λ3775 there is anomalous dispersion and that at 5350·6 the phenomenon is much weaker.

A detailed account of these experiments together with the photographs of the absorption spectra will be published shortly.

A. L. Narayan.
G. Subrahmaniam.
D. Gunnaiya.
K. Rangadhamarao.

Research Laboratories,
H.H. The Maharajah's College,
Vizianagaram.

The Theory of Hearing.

To the letters of Sir R. A. S. Paget and Mr. Wilkinson in Nature of July 19 I will reply in regard to the piano experiment by saying that what a person hears is chiefly what he expects to hear. A conspicuous example is that of hearing the tones in whispered vowels. Every observer hears a different system. In the piano experiment I can hear fairly good vowels for *ah* and *oo* when sung ; otherwise the result is vague. Yet in speech I hear every minute shading. I am quite in agreement with these gentlemen and most other writers in believing that the vowels are characterised by tones of definite pitch, but that is a matter that cannot be established by any such method.

The portamento piano experiment, however, furnishes a definite proof that the ear is not a resonating organ. When a tone is sung into the piano portamento *all* the strings vibrate more or less, and the result is a complete jangle. Exactly the same result would occur if the ear were a resonating organ. Much singing and *all* speech is portamento. If the basilar membrane acted by resonance, the voice of the singer would usually be a jangle with no pitch, and for the melody of speech we would have only a confused noise. This is exactly what I pointed out in my original letter to Nature, April 22, 1922. The piano as a resonating organ responds to portamento singing by a perfect jangle. That the ear responds by a sensation of a clear rising or falling tone is a quite adequate proof that it does not possess a resonating organ. This ought to settle the matter for good from the physical point of view. To those of us who are accustomed to work with delicate human tissues the Helmholtz resonance theory is simply unthinkable.

The resonance theory is dead and there is no use in wasting time in trying to put life into it again. The deformation theory, as explained in Nature for April 26, rests on distinct theses in strict accordance with anatomical and physiological facts, not one of which has been called in question.

E. W. Scripture.

University of Vienna.

Germanium and its Derivatives.

Until recently, germanium was regarded as one of the rarest of metals, but recent discoveries of larger sources of its minerals lend interest to any possible applications of this element. Germanium dioxide is appreciably soluble in water and an aqueous solution of a concentration of one in 5000 has a marked inhibitory action on the growth of *Bacillus coli communis*.

So far little is known concerning the organic derivatives of germanium which we are now investigating (Chem. Soc. Trans., 1924, 125, 1261). With the aid of the Grignard reaction, germanium halides have furnished germanium tetraphenyl, germanium triphenyl bromide and oxide, and hexaphenyldigermane. Water-soluble organic derivatives of germanium have also been obtained which are now under examination in this laboratory.

G. T. Morgan.
H. D. K. Drew.

The University,
Edgbaston, Birmingham, July 18.

Mathematics at British Universities.

A little time ago I turned light-heartedly to the study of relativity. I had no doubt of the sufficiency of my equipment for such study because two British universities had found me worthy of a degree in mathematics. You can imagine my surprise when I found how little connexion the mathematics of relativity had with my university studies, and what a serious study of new subjects I must undertake. Chief among the new subjects is vector analysis or tensor calculus, and I am puzzled that so many continental writers (as well as a few in this country) show a command of vector analysis, while my two universities knew nothing of it.

It is, however, some years since I left these universities, and it may be that vector analysis has now attained an appropriate position there. It is on this point that I hope your readers may help me by telling me which universities include vector analysis in their courses, and by indicating how far they go in this and other subjects preparatory to relativity. In this inquiry I am not actuated by mere curiosity. I am anxious to know, and I am sure many of your readers also wish to know, whether the teaching of mathematics in our universities is abreast of the times. I hope, therefore, that some one at Cambridge will say what is being done there, or if Cambridge is doing nothing, I hope some one elsewhere will be able to show that his university is making good the omission of Cambridge.

A Beginner in Relativity.

Surveys from the Air: the Present Position.[1]

THE issue by the War Office of the first Report of the Air Survey Committee affords an opportunity of reviewing the progress made in this method of making maps; more especially because the excellent report in question puts together, in a comparatively small book, a mass of information not easily accessible elsewhere, and is written by the authority of the War Office, the Air Ministry, and the Ordnance Survey.

In discussing the matter it is very desirable to bear in mind that the object in view is the construction of an *accurate* map. It is this factor of accuracy which creates most of the difficulties found in practice. Indeed, if we are content with a pictorial representation of the ground, or with a sketch of uncertain trustworthiness, there is no problem—the thing is already done. It is when we try to produce, by this method, a map of the same high degree of correctness that we expect from modern ground survey that we find that there are many obstacles to be overcome.

Owing to the special conditions that obtained on the Western Front during the War, the difficulties of the method were very commonly underrated. In this area there were available the old cadastral plans of France, discontinuous and some eighty years out-of-date, but still showing correctly the features which survived. The problem in this case was to correct an out-of-date map of which there existed a trigonometrical frame work. Moreover, along the British portion of the line the ground was generally flat, or only gently undulating, a circumstance which made the conversion of an air-photograph into a plan much easier than it would otherwise have been. The Committee reports that "an undue optimism as to the ease, cost, and suitability of air photo-topography was common at the close of the War."

Broadly speaking, we may tackle the problem in two ways. Either we may take the photograph of the ground without any special precautions as to the axis of the camera being vertical, and without attempting to ascertain its height above the ground. We must then, in the ordinary case, rely upon a fairly close network of measured points on the ground, and from the positions of their representations on the photograph we can, in several ways, determine the tilt, and direction of tilt, of the camera, and its height at the moment of exposure; or we may take precautions to fly level and straight at a known height.

The latter system has been carefully studied at Cambridge by Prof. Melvill Jones; and it is to him and to Major J. C. Griffiths that we owe its present development. It appears that "when the pilot is flying in air weather at a height sufficient to escape surface air pockets, the probable errors of tilt and difference of flying height have been reduced to 1° and 40 ft. respectively." Truly remarkable results. When it is considered that during the War the average tilt was of the order of 10°, it will be seen what excellent progress has been accomplished in this direction. But still, straight and level flying only solves the difficulties in special cases. When there are considerable differences of level in the terrain photographed, large errors will appear on the resulting map. Where any approach to accuracy is desired, the system of making a map from an uncorrected "mosaic" of photographs taken in this way can be applied only to level areas. But probably it can be effectively applied to the surveys of estuaries and deltas and perhaps to the mapping of large native towns, which in most cases are scarcely worth accurate large-scale ground surveys. Sometimes in war the use of uncorrected mosaics may be inevitable; but that is scarcely the question before us.

In the general case, what is required is the means of mapping hilly and undulating country at a cost which will compare favourably with that of modern ground surveys. It may be as well to state at once that this state of affairs has not nearly been reached. It looks, in fact, as if it would be a long time yet before it is reached. Much patient work is still necessary, though it is only fair to say that much has been done. Experimenters are feeling their way, and are as yet unable to decide which of many promising paths is most likely to lead to the desired goal.

Apart from the use of uncorrected "mosaics" there are two principal problems to be solved. The first is to map, by means of air-photographs, a hilly district which has been so well provided with a framework of fixed points that, in general, four of these, well distributed, will be found on each photograph. The second problem is how to survey with accuracy, from air-photographs, a limited region or gap between two surveyed areas, the region in question not being provided with any fixed points. It is not to be assumed in either problem that it is possible to arrange for the axis of the camera to be vertical; and in each problem we must take account of the hilly character of the ground, and attempt to contour it.

It may be taken for granted that the focal length of the lens is known and also the position of the optical centre of the plate. Now if, in addition, we could find the amount of the tilt and the direction of the tilt, the problem would be much simplified. The Committee, therefore, turned its attention to the determination of the tilt by means of a gyroscopic apparatus, and it is reported that during approximately straight flight the apparatus worked well and that an accuracy of one-quarter of a degree might be expected.

An alternative method of finding the tilt is to make use of a "tilt-finder," a machine devised by Major MacLeod, which reproduces, in miniature, the conditions which obtained in the field (Fig. 1). To use this machine it is necessary to know the focal length and optical centre, and to have available the positions of three ground points, which in the latest model need not be of the same height. Three planes are dealt with: namely, the ground plane P′, which need not be horizontal; the map-plane M, which must be horizontal; and the photo-plane P, of which it is desired to ascertain the tilt. By a succession of approximations it is possible to determine the tilt with a satisfactory degree of accuracy.

If the terrain to be surveyed is flat, or nearly so, and if four points of which the co-ordinates are known are shown on the photograph, then it is possible to cover the map with a rectilinear grid, and by a graphic construction to draw the representation of this grid on

[1] Report of the Air Survey Committee. No. 1, 1923. Pp. 131. (London: H.M. Stationery Office, n.d.) 4*s.* 6*d.* net.

the photograph (Figs. 2 and 3). The photo-grid will be composed of two sets of straight but converging lines. If the grid is close enough, the detail can be drawn in on the map without difficulty.

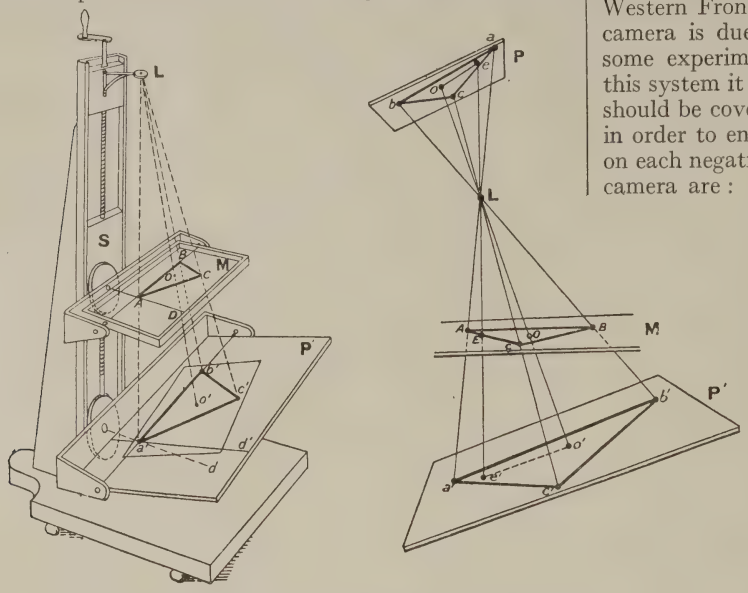

FIG. 1.—The tilt-finder (Mark I). Reproduced by permission of the Controller of H.M. Stationery Office, from the Report of the Air Survey Committee, No. 1, 1923.

The problem is, of course, capable of mathematical treatment. If there are given the focal length and at least three known points, it is possible to determine the position of the camera in the air and the constants of the plate. Where the ground is approximately level the mathematical treatment is easy; but in hilly country it becomes cumbrous — and expensive.

In hilly country, for the purpose of plotting the relief, it is useful to employ oblique photographs, in addition to those taken with the plates horizontal. If the "obliques" are taken at lower altitudes than the horizontal plates, they can be at high tilts and are then most valuable. This may involve, however, the uneconomical procedure of double flights. Generally, the more the plate is tilted the more valuable it is for determining the relief and the less valuable for planimetry.

The rectification of the air-photograph can also be accomplished photographically. This method was, in fact, in use by the British and French armies on the Western Front. An up-to-date form of the rectifying camera is due to M. Roussilhe, who has undertaken some experiments for speed, cost, and accuracy. In this system it is necessary that the area to be surveyed should be covered with a close network of fixed points in order to ensure that three fixed points shall appear on each negative. The essential parts of the rectifying camera are: a projecting lantern, a negative-carrier, a lens-carrier, and a screen-carrier. The carriers are all capable of horizontal movement and of rotation. A tracing or diagram of the three control points, plotted to scale, is fixed to the screen-carrier, and the apparatus is manipulated until the projected images of the three control points in the negative correspond with the three points on the screen-carrier. If the three points are not all in the plane of reference a second adjustment will be necessary. The adjustment having been made, the tilt can be found to within ½ degree, the position of the map plumb-point to within 10 metres, and the height to within 10 metres; the rectified print is the required map, to scale. M. Roussilhe has shown that, provided that the differences in level of the ground to be surveyed do not exceed 100 metres, and the scale of the photograph is not larger than 1 : 5000, the distortion due to relief may be neglected. The method is a promising one, especially for flat or undulating country. The time required for the whole operation for one plate is stated to have been reduced to twenty-five minutes.

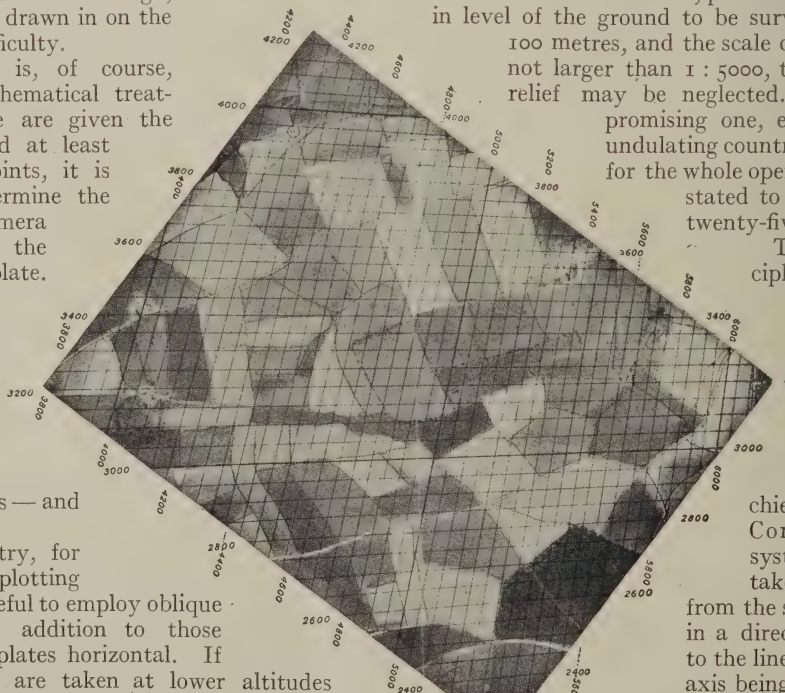

FIG. 2.—The photo-grid. Reproduced, by permission of the Controller of H.M. Stationery Office, from the Report of the Air Survey Committee, No. 1, 1923.

The stereoscopic principle has also been applied to air photo-surveying, and may be exemplified by the system evolved by Prof. Hugershoff, which is that chiefly dealt with by the Committee. In this system, photographs are taken in pairs, by hand, from the side of the aeroplane, in a direction at right angles to the line of flight, the optical axis being tilted to about 60°. Each photograph must include three fixed points; and from the positions of these points on the photograph the position of the camera in space is measured, and the direction of the optical axis. Each pair of photographs is then placed in the autocartograph, which is, in principle, much the same as the stereoautograph

Von Orel. By means of the autocartograph the map can be plotted mechanically; and by clamping the height lever at a particular height, and keeping the stereoscopic pointer (in appearance) just in contact with the ground, a contour can be traced. The whole apparatus is elaborate and expensive, and it would need many pages to describe it at all adequately. It has possibly come to stay, though it has not yet been subjected to exhaustive tests. The stereoscopic method has the great advantage that it is possible by its means to draw the contours of a bare hillside, an impossibility with any point-by-point system; and this requirement of drawing contours must be met if air photo-surveying is to have any general application to topography. A topographical map of the normal type shows the ground features by approximate contours, which are controlled by a trigonometrical framework. At present, apart from the stereoscopic methods above mentioned, air photo-surveying is incapable of supplying the contours in open country. It is therefore, at present, only fitted for the survey of flat countries. It would be waste of time and money to prepare a ground plan by air methods and then go over the same ground again for the survey of the contours.

The position that has been reached briefly this: Air photo-surveying is indispensable in war. In peace-time it has a unique field of usefulness for archæological purposes; for it has been shown by Colonel Peazeley, Mr. O. G. S. Crawford, and others, that air photographs may show ancient features that are invisible except from the air. For surveying purposes air photographs are probably, even now, of value for the mapping of estuaries and deltas, and possibly for the mapping of native towns on medium scales. It also appears likely that in flat or very gently undulating country the method can be used for the construction of cadastral plans without contours, with satisfactory speed and accuracy; and that in such circumstances the cost may be brought down to a practicable figure.

But at present, for the construction of contoured topographical maps, air photographs cannot be economically employed; and the same remark applies to the construction of maps and plans, on all scales, for all purposes, in hilly country. The future use of air photographs, so far as concerns the general peace-time application of the method to the construction of accurate topographical maps, would appear to lie in the development of stereoscopic methods.

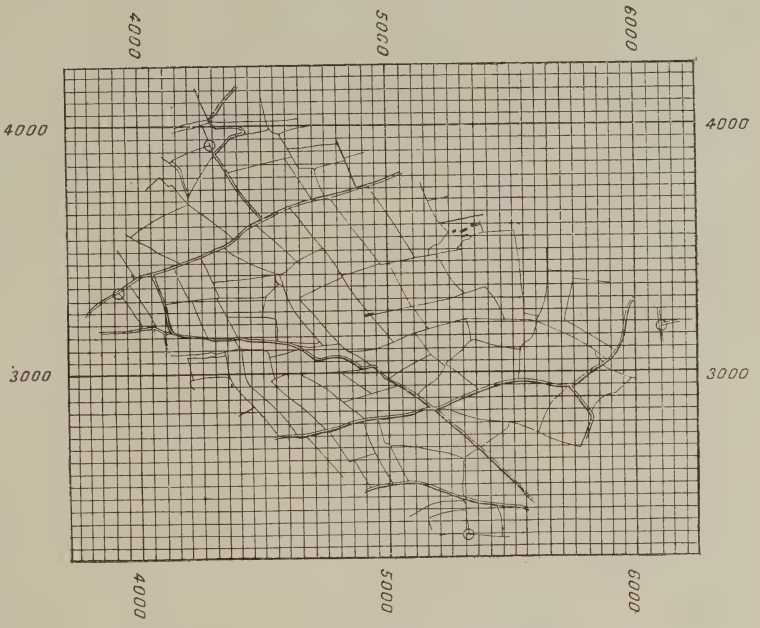

FIG. 3.—The map-grid. Reproduced, by permission of the Controller of H.M. Stationery Office, from the Report of the Air Survey Committee, No. 1, 1923.

Any one interested in the subject may be advised to purchase the Report of the Air Survey Committee, which is clearly written, well illustrated, and contains much useful information, including a short bibliography.

C. F. CLOSE.

The Reported Transmutation of Mercury into Gold.

IN NATURE of March 29 last (pp. 459-460) we printed a communication by H. Nagaoka, Y. Sugiura, and T. Mishima "on the isotopes of mercury and bismuth revealed in the satellites of their spectral lines," at the end of which the authors stated that "if the above assumption as to the mercury nucleus is valid, we can perhaps realise the dream of alchemists by striking out the hydrogen-proton from the nucleus by α-rays, or by some other powerful methods of disruption." Following this statement, on July 21 the *Morning Post* reported from Berlin that Dr. A. Miethe, professor of photochemistry and astronomy in the Technical High School at Charlottenburg, had obtained gold from mercury by the prolonged action of a high-tension electric current upon it. In the absence of details, such a report could only be received with great reserve, for in the light of existing knowledge it seemed highly improbable that the amount of energy indicated to have been used would be sufficient to disrupt the mercury atom. An account of Prof. Miethe's work containing some definite experimental details is given in the issue of *Die Naturwissenschaften* for July 18, and we reproduce these in order that the claim advanced may be justly assessed.

Some thirteen months ago, Prof. Miethe adopted an improved type of mercury-vapour lamp, made by A. Jaenicke, for his experiments on the coloration of transparent minerals and glasses induced by ultra-violet rays. Early this year, he and his assistant, Dr. H. Stammreich, observed that when the current employed was too strong, the character of the emitted rays soon changed, and that a black deposit formed inside the lamp. (It is not stated if the lamp was of quartz or of glass.) This observation was confirmed by Jaenicke, who stated that on distilling the mercury recovered from old lamps of the improved type, he had

found residues which he could not identify. He supplied Prof. Miethe with about 0·5 gram of the residues (which had been obtained from 5 kg. of mercury), and the latter after careful investigation discovered that they contained gold, in addition to other substances which were undoubtedly present as impurities in the original mercury. According to Jaenicke, all the mercury used in the lamps had been twice distilled before use. In his successful experiments, Prof. Miethe always used a potential difference of 170 volts between the electrodes, which were in direct communication with the air outside; the current was passed for 20-200 hours; and the lamp consumed 400-2000 watts. It appeared probable that a minimum P.D. is essential, for no trace of gold was found in mercury lamps of the old type that had been long in use, and negative results were also obtained with lamps of the improved type when the P.D. was below a certain figure.

Owing to the minute quantity of gold obtained, namely, 0·1–0·01 mg., special precautions had to be taken in identifying it. In every test an amount of the original mercury equal to that which was removed from the lamp was analysed and found to be free from gold both by Prof. Miethe himself and independently by K. A. Hofmann; and it was proved that no gold was present in the electrical connexions. Further, the very delicate analytical methods elaborated by Haber failed to show with certainty the pre-existence of gold. When the residue left, after distilling off *in vacuo* the mercury from the black deposit, was treated with nitric acid, there remained yellow well-formed crystals, cubical and octahedral in form, and with a highly reflecting surface; and when the mercury was removed from the deposit by volatilising it at a red heat, the resulting substance was bright gold in colour and of reniform or botryoidal shape. The substance was found to be malleable, it gave the streak of fine gold and the characteristic colour when the polished film was observed by doubly reflected light. It was easily soluble in aqua regia, and on evaporation the solution gave crystals precisely similar to those obtained when ordinary gold is so treated. Identical results were also obtained by the purple-of-Cassius test. It was not possible to make an atomic-weight determination or to attempt to prove the production of helium, hydrogen, α- or β-rays.

Obituary.

Sir James J. Dobbie, F.R.S.

JAMES JOHNSTON DOBBIE, whose death occurred at Fairlie, Ayrshire, on June 19, was born at Glasgow in 1852. He was educated at the High School of Glasgow, and entered the University of Glasgow, where he took his Arts degree with first-class honours in Natural Science. Later he worked at Leipzig in the laboratory of Wislicenus. There being no science degree at Glasgow in those days, he went to Edinburgh, and graduated as B.Sc., proceeding later to the Doctor's degree. He was elected to a Clark Fellowship at Glasgow University, and returned there and taught the class of mineralogy.

Sometime before this Dobbie had made the acquaintance of Ramsay, then a young assistant in the chemistry department of the university. Ramsay first introduced him to organic chemistry, and they read together Schorlemmer's well-known "Chemistry of the Carbon Compounds." Ramsay invited him to join in an investigation on the constitution of quinine, scarcely anything being known of the constitution of the alkaloids at that time. By oxidation with alkaline permanganate they obtained pyridine tri-carboxylic acids, which they identified, thus establishing for the first time the connexion between the alkaloids and the pyridine bases.

Soon after this Ramsay was elected to the chair of chemistry at Bristol, and Dobbie succeeded him at Glasgow. Here he continued his work on alkaloids, and also took an active share in establishing the Glasgow and West of Scotland Section of the Society of Chemical Industry, of which he was the first secretary.

In 1884 Dobbie was elected to the chair of chemistry in the newly founded University College of North Wales at Bangor. His first work was to get laboratories built and equipped, and to organise the teaching of his department. He resumed his research work on alkaloids, and made, in particular, a very complete investigation of the alkaloids of *Corydalis cava*, working out the constitution of corydaline and investigating also the structure of the associated alkaloids. This work, necessarily complicated, was rendered still more difficult by the high cost of the alkaloids, so that the investigation had to be carried out with very small quantities of material: the results were communicated in a series of papers to the Chemical Society from 1892 to 1904. A little later he took up the study of the relation between the ultra-violet absorption spectra and the constitution of organic compounds, working at first with the late Sir W. N. Hartley, and later with other workers. In particular, they showed how the method could be applied to determine the constitution of tautomeric bodies.

Dobbie's work at Bangor, however, was by no means limited to that of his own department. He felt that in an agricultural country such as North Wales, one of the proper functions of the college was to do everything possible to promote its chief local industry. He spent several vacations on the Continent studying methods of agricultural education, and started a campaign for the founding of an agricultural department at Bangor. Funds had to be collected and the interest of the land-owning classes and the farmers, as well as that of the Board of Agriculture, aroused. After several years of strenuous work the agricultural department was at length inaugurated in 1894. Courses were provided leading to a diploma and later to a degree in agriculture, while a comprehensive scheme of extension lectures and experiments was devised. This was the first agricultural department to be founded in connexion with a University College, and it is impossible to overrate the importance of Dobbie's pioneer work at Bangor in the development of agricultural education. He took a leading part in the work of the foundation of the University of Wales, and the college and the university owed much in these early days to his sane judgment and great administrative skill.

In 1903 Dobbie was offered and accepted the post of director of the Royal Scottish Museum in Edinburgh, but gave up his work at Bangor with considerable reluctance. His wide interests and scholarship combined with his administrative ability made him an excellent director. He threw himself into the work of the Museum with characteristic energy, and greatly extended the collection of Egyptian antiquities, a subject in which he was much interested. He also collected funds to acquire for the Museum the valuable Joel Paton collection of armour and antiquities, and greatly developed the technical collections. He did not, however, relinquish his connexion with chemistry, but continued his research work, a regular series of papers being contributed to the Chemical Society on absorption spectra and alkaloid work.

In 1909 Dobbie was appointed principal of the Government Laboratory in succession to Sir T. E. Thorpe, and was at once required to undertake the reorganisation of the laboratory. This was made a separate Crown Department in 1911, dealing with chemical matters arising from all Departments of State, and Dobbie was the first to hold the position of Government Chemist. Here he continued his investigations in absorption spectra and on the alkaloids. His tenure of office covered the difficult years of the War, when the strain on his department was great. He served on various commissions and committees, and in particular his services on the Royal Commission on Rewards to Inventors, the Universities Grants Committee, and the Nitrogen Products Committee may be specially mentioned. He also acted for fourteen years as adviser on the research schemes in physics and chemistry to the Carnegie Trust for the Universities of Scotland.

Dobbie was elected a fellow of the Royal Society in 1904, and in 1915 his services to science, both as an investigator and as administrator, were recognised by the King, who conferred the honour of knighthood upon him. He received the degree of LL.D. from the University of Glasgow in 1908, and that of D.Sc. from the University of Wales in 1920. He was elected president of the Institute of Chemistry in 1915, and of the Chemical Society in 1919.

The foregoing is a bare outline of a life of varied and fruitful activity. In an unusual degree Dobbie combined the patience and lucidity of the born teacher, the fertility of ideas and resourcefulness of the research worker, and the clear common sense, critical yet always constructive, of the wise administrator. In addition to all these he had much of the scholar's temperament. Reading widely, but never without fine discrimination, he was indeed the "full man" of Bacon's aphorism, and his mind was a storehouse of information over a wide range of literature and history. To the end of his days the classics were his constant solace and relaxation, and he was a living negation of the supposed antipathy between science and the humanities.

Beloved by his students and fellow-workers, in the lives of his intimate friends he leaves a blank that can never be filled. He is survived by Lady Dobbie, one son, and two daughters. ALEX. LAUDER.

WE regret to announce the following deaths:

Sir George Beilby, F.R.S., distinguished by his work in industrial chemistry, fuel technology, and many other departments of pure and applied science, on August 1, in his seventy-fourth year of age.

Dr. R. S. Woodward, president of the Carnegie Institution from 1905 to 1920, and formerly professor of physics in Columbia University, on June 29, at seventy-five years of age.

Current Topics and Events.

THE Toronto meeting of the British Association opened on Wednesday evening with the delivery by Sir David Bruce of his presidential address on the prevention of disease, which is printed in full in this week's Supplement to NATURE, together with abstracts of most of the addresses of presidents of Sections. The provisional programmes of the Sections were described in our issue of July 26, and articles upon the main subjects discussed will appear in our columns later. At the inaugural meeting, the following congratulatory message from H.R.H. the Prince of Wales was read: "Dear Mr. President, Will you be good enough to convey to the members of the British Association at their inaugural meeting in Toronto my cordial good wishes for a very successful session? My knowledge of Canada assures me that your visit will be warmly welcomed, and that nothing but good can come of such a gathering, where the representatives of the most advanced thought from the Old Country will meet in discussion the equally keen and active intellects of the Younger Land. My interest has been particularly arrested by one item that is to come up for discussion, namely, the educational training of boys and girls in this country for life overseas. The call of the Empire for a wider distribution of the home population, for men and women to open up the vast uncultivated areas in the great Overseas Dominions, is more imperative to-day than at any time in its history. I congratulate the Association on thus showing in its deliberations such a broad interest in these problems, and I trust, and indeed am confident, that the influence thus exercised may result in great and extended benefits to the Empire."

A STRIKING illustration of the attitude of Parliament and the heads of State departments towards scientific workers is afforded by an examination of the personnel of the committee appointed by the President of the Board of Trade "to inquire into and report upon the conditions and prospects of British industry and commerce, with special reference to the export trade, and to make recommendations with regard thereto." The appointment of this committee is the outcome of representations made by Sir A. Shirley Benn on May 21 in the House of Commons. On that occasion Major A. G. Church directed attention to the fact that the proposal not to include on the committee a representative scientific worker—other than economists—suggested that the House

did not realise that the greater part of the export trade of Great Britain was based upon the application of scientific discoveries. The function of the highly qualified scientific worker or technician engaged in industry is to improve industrial processes, to develop new processes, and, most important of all, to create new industries. Any national inquiry into trade must, therefore, necessarily consider the methods by which practical applications of science may be profitably encouraged. In the memorandum furnished to the Committee of Inquiry, upon which workers in science and technology are not represented, Mr. Sidney Webb states that it is their duty to make "an inquiry into British productive capacity and organisation . . . the present and future adequacy of raw materials and possible improvements in their utilisation, and the part played by the United Kingdom in new developments of industry, particularly those which are the outcome of scientific research." How such an inquiry is to be made on satisfactory lines without the assistance of those who possess a knowledge of science and its possibilities is difficult to understand. It is not enough to call scientific workers to give expert evidence; they should be given representation on the committee and share to the full responsibility for the report to be produced.

THE appointment of the Rev. Canon E. W. Barnes, F.R.S., Canon of Westminster, to the Bishopric of Birmingham, is a noteworthy sign of the times. Canon Barnes is a distinguished mathematician with wide scientific knowledge as well as a leader in theological thought, so that he represents the progressive spirit of both science and religion and combines the principles of truth and righteousness for which each should stand. In the early fifties of the last century, Robert Braithwaite Batty, second wrangler and first Smith's prizeman, gave up his promising career in England to preach the gospel, as then understood by the "evangelical" school of theology, to the natives of India. His humble missionary effort, contrary to medical advice, was closed by his death in a year's time. Canon Barnes, also second wrangler and first Smith's prizeman, is now nominate Bishop of Birmingham. The contrast is indeed strange and marks a new stage in the evolution of spiritual thought.

SIR MAX MUSPRATT, Bart., in addressing the eighth annual general meeting of the Association of British Chemical Manufacturers on July 17, said that great strides have been made recently in effecting co-operation among manufacturers and others associated with chemical industry, notably in the organisation of the chemical exhibits at the British Empire Exhibition. These exhibits have not only been instructive to students, but they have also been the means of bringing home to politicians and the public the importance of chemistry to the nation. There is considerable conflict of opinion within the Association concerning our dyestuffs policy: the council is trying to keep a balance between the opposing interests, and is advocating what it considers best for the Association as a whole. In supporting the principle of the Consolidated Factories Bill, the council approves of any measures that will make employment in factories easier and more pleasant, but it disapproves of hard and fast regulations that are unnecessary, or costly, or Utopian. Sir Max Muspratt is not hopeful that much can come out of the Rating of Machinery Bill, yet he hopes that the inquiries now being made into the general principles of rating will result ultimately in equitable treatment for chemical undertakings: the projected Census of Production will, if properly carried out, aid greatly in solving problems of unemployment, health, taxation, and rating. Sir John Brunner, Bart., referred to the Chemical Engineering Department of University College, London, and said that, although many hold that such education can produce only half-baked engineers and half-baked chemists, he thinks that there are many places in our Empire where large staffs cannot be afforded and where men trained in a chemical-engineering department could take control, if not of chemical works proper, of works in which chemistry plays a very prominent part, for example, in sugar factories.

WITH reference to our paragraph of July 19, p. 96, on the subject of trichlorophenylmethyliodosalicylic acid, it appears that this substance is to be classed among those actively germicidal owing to their inherent properties, rather than amongst those which owe their antiseptic powers to their ability to set free chlorine. The compound is very stable and its solution in water can be boiled without undergoing decomposition: it retains a great part of its germicidal action in serum. Used as an antiseptic in a 1 per cent. solution or less, it appears to owe its power to two distinct modes of action; on the one hand it stimulates the leucocytes, and thus aids the body's own defensive processes: on the other, it combines with the proteins of the bacteria by virtue of its chlorine groups; this combination is presumably with the amino-groups of the protein molecules. In this way it is attached to the micro-organisms and hinders or abolishes their activity; the phenyl and iodine radicles as well as the salicylic acid are themselves antiseptic of varying potency, and it is probable that with the attachment of the compound to the bacterial protoplasm by means of the chlorine group, the other groups are enabled to exert their action under more favourable conditions. Analgesic properties are also ascribed to it, owing to the fact that the chlorine groups are attached to the benzene nucleus. Finally, it is claimed by Dr. Callimachi that it shows little affinity for the protein molecules of human tissues, while reacting selectively with those of bacteria.

THE International Congress of Architects concluded a week's programme in London on August 2. Organised by the Royal Institute of British Architects, the meeting had for its object the discussion of architectural education, which is controlled in Britain and the Dominions by the examinations of the Royal Institute's education board. To reach the status necessary for the successful design and supervision of modern buildings requires a course of study not

ess lengthy or exacting than that required for other professions, and the requisite training is provided in architectural schools, which usually give a four years' course, during which design, construction, and the technical and legal aspects of an architect's work are the subject of study. Discussions on three successive days were centred around architectural education of the past, present, and future, under the respective chairmanships of Lord Crawford, Sir Reginald Blomfield, and Mr. Cass Gilbert (U.S.A.). In addition to a display of rare architectural books, a unique collection of students' drawings from all countries, large enough to require both Grosvenor House and Devonshire House for its accommodation, was exhibited. This is the first international meeting of architects held, and in addition to Britain and the Dominions, thirteen other countries were represented. While British schools are to be congratulated on their work, it must be confessed that the drawings of foreign countries, especially those of the United States, must be given the first place for boldness in conception and possibly also for skill in composition.

The meetings of the British Pharmaceutical Conference were held at Bath on July 22-24. At the opening session the Mayor of Bath welcomed the conference to the city, and the chairman, Mr. Edmund White, delivered an address entitled "Pharmacy: Present and Future." He first directed attention to the changes which are gradually taking place in the practice of pharmacy as the result of changes in medical practice. The *materia medica* has been enriched by the addition of a large number of synthetic substances and animal products such as gland extracts, sera, and vaccines. Pharmacists should be trained to deal with these new developments and also to undertake the newer methods of laboratory diagnosis for the assistance of the medical practitioner. Mr. White then reviewed the work of the Consultative Council on Medical and Allied Services set up by the Ministry of Health, and, from consideration of the report of that body, concluded that much of the work of the clinical laboratories, which it is proposed to set up, could be done by pharmacists. As to the Therapeutic Substances Bill, he thought that the Pharmaceutical Society should take an active part in the examination and standardisation of remedies by physiological and biological methods. The twenty-three papers read at the science meetings included: a number of communications on bismuth compounds from the Research Laboratories of the Pharmaceutical Society; a study of Benedict's method for the estimation of glucose; the preservation of anæsthetic ether; carbon tetrachloride for medicinal purposes; assay of mercurials in ointments; and papers dealing with the following drugs: tragacanth, acetannin, valerian, erythrophleum, artemisia, nux vomica, *Strychnos cinnamomifolia*, and tannin-containing drugs. The delegates from branches of the Pharmaceutical Society met under the presidency of Mr. F. Pilkington Sargeant and discussed the control of pharmaceutical specialities; also articles of pupilage, and pharmaceutical service in the Army. The programme of social events included the Civic Reception, a banquet, concerts, and motor excursions in the beautiful country surrounding the city of Bath.

The Council of the Royal Meteorological Society has awarded the Howard prize for 1924 to Cadet J. M. Goode of H.M.S. *Worcester* for the best essay on "Monsoons." The prize was competed for by cadets from the following institutions: H.M.S. *Worcester*, H.M.S. *Conway*, and the Nautical College, Pangbourne. The prize was presented to the successful cadet at the annual prize-giving on the *Worcester* on July 31.

Prof. J. C. Fields informs us that the following conferences are to be held at the International Mathematical Congress at Toronto on August 11-16: "Some of the Characteristic Features of Twentieth Century Pure Mathematical Research," Prof. W. H. Young; "Science and Engineering," Sir Charles Parsons; "Modern Norwegian Researches on the Aurora Borealis," Prof. Carl Stormer; "Solved and Unsolved Problems in Dynamical Meteorology," Prof. V. Bjerknes; "Sur l'intégration des équations aux dérivées partielles par des intégrals définis," Prof. J. Le Roux; "Sur la déformation projective des surfaces," "Sur les relations entre la théorie des groupes et la géométrie," Prof. E. Cartan; "Sur les nouveaux appareils multiplex de télégraphie," J. B. Pomey; "Principe de réciprocité dans les sciences appliquées," Prof. G. Puppini; "Géométrie algébrique," Prof. F. Severi; "Sur le calcul des variations," Prof. L. Tonelli; and "On Ballistics," General Charbonnier.

A conference, under the auspices of the British Non-Ferrous Metals Research Association, will be held at High Leigh, Hoddesdon, Herts, during the week-end September 5-8, to which are invited all who need to utilise information systematically, or are interested in the conduct or operation of information bureaux, intelligence services, and special libraries. The programme will include papers and discussions on the functions, future developments, and the methods and equipment of intelligence bureaux, and on their relations with other institutions, including national and public libraries. It is hoped to obtain representatives of such varied fields of activity as government and municipal departments, technical and research institutions, industrial concerns, financial houses, insurance offices, newspapers, and civic and social organisations, all of which have a common interest in the collection, treatment, and dissemination of facts and information relevant to their particular activities. Further information may be obtained from Mr. A. F. Ridley, Athenæum Chambers, 71 Temple Row, Birmingham.

The fifth Entomological Meeting was held at Pusa on Feb. 5-10, 1923, under the chairmanship of Mr. T. Bainbrigge Fletcher, Imperial Entomologist. The Report of its proceedings has recently come to hand, and, although it is less bulky than some of its predecessors, some sixty-one papers are included. These represent almost every branch of applied entomology and afford ample testimony of the importance the subject has attained in India. The institution of meetings of this description brings together workers

who are often isolated at great distances apart with little or no opportunities of direct intercourse. The means thus afforded for the ready interchange of information and ideas also attains a more lasting value by the publication of these very fully illustrated Reports. Among the various papers included in the present volume, one of the most important is that by Mr. T. Bainbrigge Fletcher on the possible introduction of the American cotton boll-weevil into India. It appears that the risk of this pest securing a footing in that country is very real, and, after considerable discussion, the Conference passed a resolution that the Indian Central Cotton Committee should consider the advisability of recommending the total prohibition of cotton from America. As an alternative, it is suggested that all bales containing such cotton should be confined to Bombay. The subject of the teaching of entomology in the Indian universities also came up for discussion. The meeting recommended and passed a resolution to the effect that entomology be taught as of equal rank with other branches of biological science in the courses of study for the examinations for degrees in science, including agriculture.

A FISHERY expert is required by the New Zealand Government for co-operation with the chief inspector of fisheries. Particulars of the appointment and form of application may be had from the High Commissioner for New Zealand, 415 Strand, W.C.2. The completed form must be returned by, at latest, August 23.

SOME appointments are about to be made in connexion with the Fuel Research Station, East Greenwich. Candidates must be honours graduates in chemistry (or have equivalent qualifications) with experience in the technology of fuels; or be honours graduates in engineering (or have equivalent qualifications) with similar experience. Research experience is essential for a higher post in chemistry, and industrial experience for a higher post in engineering. Applications must be made on a form obtainable from the Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1, returnable not later than August 20.

THE American Oil Chemists' Society has established a new quarterly journal which will be the official journal of the oil and fat industry in the United States. The new publication will deal with the chemical considerations of oils, fats, and related materials such as oil meal feeds and fertilisers, paints, soaps, foods, and packing-house products. H. S. Bailey, chief chemist of the Southern Cotton Oil Company, heads the board of editors, composed of the leading American chemists in this field. The first number is to appear this month from the press of the publishers of the American Chemical Society publications. Correspondence regarding subscriptions should be sent to Fred H. Smith, Managing Editor, Experiment, Georgia, U.S.A.

THE Wisconsin Survey Bulletins Nos. LII. and LIV. include a general soil survey of the south part of North Central Wisconsin, and a detailed survey by counties of the southern and older portions. Each section is preceded by a general description of the area concerned, with a summary of the various series of soils found in the district. These groups are then treated in detail, special attention being directed to the economic aspects, such as topography and drainage, native vegetation, and the present state of agricultural development. Each survey is illustrated by an excellent soil map to which a legend is appended in which the soils are grouped according to their surface features and drainage, and are further classified in accordance with their uses and adaptation, fertility, and methods of improvement.

A NEW and much more convenient *format* has been adopted by the Ministry of Agriculture and Fisheries for its fishery publications: it is understood that this is a very great reform, accomplished with difficulty. Three papers are noticed here: Vol. 6, No. 1, a study by Dr. E. S. Russell of the seasonal variations in the chemical composition of the oyster. The paper is based on a large series of analyses made by the staff of the Government Chemist. Vol. 6, No. 5, by J. N. Carruthers, deals with the "intensive" plaice investigations of 1921, particularly the marking and transplantation experiments. Vol. 7, No. 1, is an account of the development of the cod by Prof. A. Meek. The author has been able successfully to make sections of developing cod eggs—a result of considerable value—and has evidently made a contribution of importance to the study of teleostean embryology. This embryological detail has, however, been omitted from the paper "as unsuitable in a fisheries publication," and the figures and results actually included are mainly such as have long been familiar in fisheries reports—pictures of fish embryos as seen through the outer membranes and useful only for the purpose of identification of the eggs.

THE Leicester Museum, Art Gallery, and Library Bulletin, of which the first number was issued in June, is in itself a token of progress. It announces another advance in the experimental appointment of Miss F. A. Rogers as guide demonstrator to all three institutions; the extension of this service to the libraries of the town is, we believe, a novelty. The main object of the Bulletin is to direct attention to recent accessions. Those mentioned in the present number comprise an ancient Egyptian funeral boat of the XII. Dynasty, a single-handed turret clock of about A.D. 1700 from Aylestone Church, a bronze, "The Mourning Woman," by Epstein, and a number of books on hosiery manufacture and the related textile industries. The Bulletin is intended, for the present, to be distributed gratis at quarterly intervals.

A BEAUTIFUL album of views in the Canton of Graubünden or Grisons has reached us from the Grisons Tourist Information Office, Coire (Chur), Switzerland. The album includes striking illustrations of Klosters and the Canardhorn, Arosa, Flims-Waldhaus with its lakes and pine-woods, St. Moritz, Silvaplana, Maloja, the Morteratsch glacier, the fine Bernina Pass to Alp Grun with the valley and the lake of Poschiava below, the National Park, Pontresina, and many other places in the Upper and

Lower Engadine. Few areas in Switzerland can offer such a variety of interest and charm as the Engadine. There are mountain peaks, glaciers, well-shaded walks, and lakes, while the remarkable railway, going to a height of 7400 feet, from St. Moritz to Tirano, with conveniently placed stations, make most of the beauty spots in the district easily accessible to visitors who are not mountaineers or cannot undertake long excursions in the high Alps. In the Engadine the mountains are wooded to a greater height than anywhere else in the Alps, and as the general level is about six thousand feet, the district has advantages over most of the places visited by tourists. Pontresina is one of the best centres, and a holiday spent there cannot fail to be of benefit to both body and mind.

MESSRS. DULAU AND CO., LTD., have just circulated a catalogue (No. 114) of books and papers on conchology, mollusca, and minor classes—recent and fossil. Upwards of 1300 titles are given in the list, which will doubtless interest many readers.

READERS of NATURE on the look-out for bargains in books should obtain Catalogue No. 237 from Messrs. W. Heffer and Sons, Ltd., Cambridge, in which are given the titles of many books of science now offered for sale in new condition at greatly reduced prices—the books being "remainders."

WE have received from the British Dyestuffs Corporation, Ltd., a price list of fine organic chemicals for research work, indicators, microscopic stains, and medicinal and photographic chemicals. A very extensive range of products at reasonable prices is available, and it is evident that great progress has been made in the fine chemical industry.

MESSRS. H. K. LEWIS AND CO., LTD., 136 Gower Street, W.C.1, have just issued, at 1s. net, a supplement (1921–1923) to the catalogue of their Medical and Scientific Circulating Library. It should be very useful, not only to users of the library, but also to students in general of scientific literature, being practically a list of the science books published during the period named, consisting of a classified index to subjects in addition to the catalogue itself, which is arranged alphabetically under the names of the authors. It gives the date of publication of the volumes included.

MESSRS. W. H. HARLING, of 117 Moorgate, London, have just issued a new illustrated catalogue of drawing instruments, mostly of their own design and manufacture. These include, besides the usual group of engineers' drawing materials such as scales, parallel rules, T-squares, set squares, drawing boards, etc., a few more elaborate instruments, such as pantographs and eidographs, which should appeal to the increasing number of people who frequently resort to graphical methods. There is a cheap new pantograph which enables drawings and plans to be reduced by sixteen different ratios and enlarged to four times. A more expensive but much more accurate instrument is the eidograph, designed to provide the accuracy required for fine details of map construction. The instrument will enlarge with this accuracy up to a ratio of 1 in 4.

ERRATUM.—Dr. H. O. Forbes writes: "By a very regrettable oversight in correcting the proofs of my communication in NATURE for August 2, 'Pre-Columbian Representations of the Elephant in America,' Dr. Maudslay's name was misspelt Maudsley."

Our Astronomical Column.

ENCKE'S COMET.—This comet was detected on its return by Prof. G. van Biesbroeck at the Yerkes Observatory on July 31. Its position at $20^h\ 45{\cdot}6^m$ G.M.T. on July 31 was R.A. $3^h\ 24^m\ 53{\cdot}4^s$, N. Decl. 28° 6′ 27″, Magnitude 16·0. The position is within 1′ of Matkiewicz's prediction, according to which perihelion will be reached on Oct. 31·42 G.M.T. The comet should become visible to ordinary telescopes in the last week of August.

THE TOTAL LUNAR ECLIPSE OF AUGUST 14.—We are passing through a period of eighteen years (1920–1938), during which no total lunar eclipses are visible in England under really good conditions. That on August 14 will, however, give some opportunities for observation, especially towards the close of totality. Sunset is at 8.25 P.M. (summer time), the middle of eclipse at 9·20, the end of totality 10.9, last contact with umbra 11.9. The eclipse is nearly central, its magnitude being 1.66 in terms of the moon's diameter. The degree of illumination, and colour, of different portions of the eclipsed moon should be studied, since they give interesting information as to the transparency of the terrestrial atmosphere. Total eclipses can also be used for obtaining improved values of the moon's diameter, by observing the occultations (both disappearance and reappearance) of faint stars. This requires co-operation between a large number of observers; the moon will be too low for observations of this kind in Europe, but some lists have been prepared for southern observers.

A NEW FORM OF ORRERY.—The *Times* of July 31 describes a very interesting method of demonstrating celestial phenomena which is being installed in the Deutsches Museum at Munich. It was constructed by the well-known optical firm, Messrs. Zeiss, of Jena, and consists of about forty optical projectors which throw images of the various heavenly bodies on the white inner surface of a spacious dome. Their relative movements and changes of aspect can be exhibited in an instructive manner.

The ordinary cinematograph can be usefully employed as an aid to astronomical education. It will be remembered that Mr. Maskelyne took a successful film of the total solar eclipse of May 1900 (exhibited at a meeting of the Royal Astronomical Society), and the attempt was repeated in Australia in 1922; but no one seems yet to have realised the possibilities of the method in explaining elliptical or parabolic motion, or various other points in which a moving picture would give far more convincing demonstration than the ordinary diagrams of the text-books.

THE PREPARATION OF THE "GESCHICHTE DES FIXSTERNHIMMELS."—Prof. R. Schorr writes to say that the preparation of this work is being continued at Berlin, Prof. Paetsch having been appointed by the Prussian Academy of Sciences to superintend it. Prof. Schorr is making an independent study of the proper motions of the stars contained in the published volumes (R.A. 0^h to 2^h). The note in this column on July 12 gave the erroneous impression that he was taking a part in the Geschichte itself.

Research Items.

THE ANTIQUITY OF MAN IN CALIFORNIA.—In *Science* for July 4, Dr. John C. Merriam, in surveying the results of the investigations into the question of the antiquity of man in California carried out by the University of California during the last twenty-five years, points out that the Californian coast region has been in almost constant movement throughout the later geological periods and thus affords a continuous record of the processes of erosion and deposition and of the life of the region during these times. Four lines of investigation have been followed :—(1) the shell-mounds have been examined from the deposits of known culture to those of the earliest times ; (2) cave deposits have been explored ; (3) pleistocene and recent land, stream, lake and marine deposits in which human remains are likely to be found have been studied ; and (4) the evidence relating to the occurrence of human remains or implements in gold-bearing gravels or other ancient deposits has been reviewed. Up to the present, all human remains discovered belong to the type which has been recognised as "modern" and none belong to a geological formation older than the recent period. In the same issue of *Science*, Dr. Chester Stock follows with an account of the geological conditions in which the skeletal remains of six individuals were found in the course of the construction of a sewer at Los Angeles in March last at depths of 18 ft. and 23 ft. The skulls, so far as they have been compared, are of modern type. Some of the remains are considerably mineralised. They present the appearance of having been mired in under bog or marsh conditions rather than washed in. No pleistocene or recent mammals were associated with the human remains, but a comparison with similar deposits in the immediate vicinity suggests the probability of a date later than pleistocene, though of considerable antiquity.

NEW SPECIES OF SHIPWORMS IN BERMUDA.—As part of the inquiry taking place in the United States on the activities of shipworms, Dr. E. L. Mark, Director of the Bermuda Biological Station, installed test-boards at four stations in Bermudan waters. The specimens of shipworms which attacked these blocks have been examined by W. F. Clapp (Proc. Amer. Acad., Arts and Sci., vol. 59, 1924). He reports that the attacks were not so severe as those caused by shipworms at Key West, Florida, and in the West Indies, but the ravages by Limnoria were so extensive that the posterior ends of many of the shipworm tubes were soon exposed to the action of the water, resulting in the premature death of many of the shipworms, so that specimens of large size were rare. The destruction caused by Limnoria was found to be about an inch in twelve months. Of the six species of shipworms received in the test blocks three are new ; descriptions of two of these are given, but the author desires further material for the study of the third species before giving an account of it. The genus Bankia (Xylotria) is not represented either in the present collections or in any previous records from Bermuda.

ADDITIONS TO THE BRACKISH WATER FAUNA OF SPAIN.—There is still much to be done in the investigation of brackish water faunas throughout the world, and if the curious discoveries of Enrique Rioja, in the Rio de San Nicolás at Gandía on the west of Spain, are to be taken as typical the investigations will yield some startling results in geographical distribution. He found, in the first place, in the streams debouching in the harbour of Gandía, colonies of a small serpulid worm which spread over stones, gre on the submerged keels of old boats and such lik The serpulid he identifies as *Mercierella enigmatic* a species described by Fauvel, in December 1922, ; occurring in the brackish water of the canal at Cae the only place where it has been found until no Rioja gives a good description and some excelle figures of the species. (Bol. Real Soc. Espag. His Nat., tome xxiv., 1924, p. 160-169.) But growi amongst the tubes of Mercierella was a more remarl able form, a minute hydroid which the auth identifies with *Annulella gemmata*, a new genus an species minutely described by Ritchie from colle tions made at Port Canning, Bengal. The characte of the two forms agree ; in Bengal, as in Spain, t species frequented brackish water ; and in Spa Rioja has been able, as Annandale was in India, keep examples alive in the laboratory in a mixtu of sea and fresh water. This occurrence of Annulell so far distant from its original place of discover indicates either a very widespread distribution brackish water species, or possibly an environment effect of this particular medium, inducing clos convergence of structure, in forms not necessaril directly related.

THE SYMBIOTIC ORGAN IN APHIDS.—In his studi on the development of Aphids, L. B. Uichanc (*Philippine Journ. Sci.* vol. 24, No. 2, 1924) dea especially with the history of the symbiotic organ mycetom. The follicular epithelium of the ovar apparently becomes infected with the symbiont which remain in a dormant condition until stimulate to multiplication by the development of the egg. Th symbionts break through the follicular epithelium an invade the embryo and especially the vitellophags— which the author calls mycetoblasts. The relation these to the inflowing granular mass—suggestive phagocytosis—lends support to the view that th symbionts are extraneous organisms and not by products of the insect's own metabolism. Th mycetoblasts form a globular mass in which definit cellular differentiation takes place shortly befor segmentation of the germ-band, some thirty t seventy mycetocytes being produced. After birth the aphid, the mycetocytes, which lie in the abdomina cavity, do not further divide, but they increase in siz and the symbionts multiply. In the adult aphid, th mycetocytes begin to degenerate one by one until a the end of life very few remain. The mycetom i present in every aphid whether male, female, o parthenogenetic. In its development, the aphid eg differs from that of related groups in that the peri plasm and afterwards the blastoderm leave an openin at the posterior pole so that there is direct communica tion between the follicular epithelium and the eg cavity. The author regards this as a special adapta tion by which the symbionts are enabled readily t enter the egg cavity.

ESTIMATION OF WIND ABOVE FOG.—Mr. L. F Richardson has devised a method for use in estimatin the wind above fog or low cloud which he describes i Meteorological Office Professional Notes, Vol. 3, No 34. The procedure is relatively simple. In th middle of a large uninhabited field a steel roof i supported on posts. The observer shelters under thi roof, through a hole in which is projected a smooth bore gun. The gun is mounted on a special mountin which enables the observer to vary its tilt. The aim of the observer is to vary the tilt in such a way tha the ball which is fired from the gun falls on the roof

The tilt which attains this object is called the balancing tilt, β, and it is read in two components, the components which Mr. Richardson designates by β being the cosines of the angles between the axis of the gun and the east-west line and the north-south line respectively. The gun is first loaded with a steel ball and sufficient powder to carry the ball up to a moderate height, say 100 m. By trial and error, and the use of a table giving corrections to β necessary to correct certain errors in point of fall of the ball, the tilt necessary to bring the ball back down on the roof of the shelter is evaluated. The charge of powder is then increased so that a greater height is attained, and so on by successive stages. The limit of height attained by Mr. Richardson appears to have been about 750 m. The height attained by the ball is evaluated by noting the time of absence of the ball, *i.e.* the time from firing until the return impact on the roof. The raw material of observation thus consists of certain times of absence with the corresponding values of β in two directions. The computation of winds at different levels is carried out by the use of certain formulæ given by Mr. Richardson in a paper in Phil. Trans. R. Soc. A. Vol. 223, "Theory of the Measurement of Wind by shooting Spheres Upward." The process is quite straightforward and simple. The paper before us does not indicate the degree of accuracy which may be expected from such observations.

THE RADIOACTIVE CONSTANT OF RADON.—In the *Comptes rendus* of the Paris Academy of Sciences, May 26, Mlle. I. Curie and Mlle. C. Chamié describe a new method of determining the above constant. Suppose two bulbs could be obtained, containing exactly equal quantities of the gas, in equilibrium with the rapidly evolved active deposit; one of them is placed in an ionisation chamber and produces a current i, which decreases with the time. The instant t when i passes through a certain value a is observed, and then the two bulbs are placed together in the chamber, and the instant t' observed when the ionisation current again passes through the value a; then $T = t' - t$ is the half life period of radon. In practice, it is not possible to obtain two bulbs with exactly equal quantities of the gas; but it is shown that if the quantities q_1 and q_2 at time o are nearly equal ($q_1 < q_2$), and the times t_1 when one bulb produces the ionisation current a, t_2 when the other bulb produces the same current, and t', when the two bulbs together give a, are determined; then $T = t' - \frac{1}{2}(t_1 + t_2)$. Details of the experimental method employed are given, and the results of four determinations agree to 0·1 per cent., giving $T = 3{\cdot}823$ days with an accuracy equal at least to 1 in 2000, and probably higher than this. Mme. Curie found $T = 3{\cdot}85$ in 1910, Sir E. Rutherford confirmed her value in 1913, and Bothe and Lechner determined $T = 3{\cdot}810$ in 1921.

DISTRIBUTION OF ENERGY IN THE SPECTRUM OF A MERCURY ARC.—M. G. Athanasiu describes in the *Comptes rendus*, Paris Acad. Sci., June 16, measurements of the energy of a number of lines in the spectrum of the mercury arc, with different electrical inputs. The observations were made by means of a thermopile and galvanometer. The lines of the first triplet of the sharp series, the three groups of lines forming the first triplet of the diffuse series, and the three groups forming the second triplet of that series were investigated. The group of yellow lines 5769-90 was also measured. Inputs from 100 up to 300 watts were employed. The energy curves of lines belonging to the same series have the same general appearance, and the ratio between the intensities of two lines of the same series remains nearly constant when the watts are varied. The deviations in the case of the first triplet of the sharp series are not larger than the experimental error (3 per cent.). In the case of the diffuse series the deviations are somewhat larger; this might be expected, since each of these groups contains a line belonging to a different series, the combination series $1p - Dm$ (Fowler). For two lines belonging to different series the ratio of the intensities varies with the watts between large limits, and may be inverted, the energy curves cutting one another. The ratio of the intensity of the yellow group to that of the green line, $\lambda 5460$ (the first line of the first triplet of the sharp series), changes in the lamp studied from 0·5 for 100 watts to 1·25 for 300 watts.

THE NUMBER OF α-PARTICLES EMITTED BY RADIUM.—In the *Zeitschrift für Physik*, June 12, V. F. Hess and R. W. Lawson criticise a recent paper by Geiger and Werner, who have obtained for the above number $3{\cdot}4 \times 10^{10}$, agreeing with the value originally found by Rutherford and Geiger, but differing from Rutherford's later value, $3{\cdot}57 \times 10^{10}$, and from that found by the authors in 1918, $3{\cdot}72 \times 10^{10}$. It is suggested that the platinum used in the construction of the container employed for the emanation, which had to be heated in the course of filling, occluded emanation when cooled; this might easily produce an error of 10 per cent. It is doubtful whether Geiger and Werner are correct in thinking that their scintillation screen, in which powdered zinc sulphide was mixed with castor oil or turpentine oil, gave scintillations corresponding to almost 100 per cent. of the total α-particles, as was the case with the zinc sulphide alone (99·6 per cent.). The method adopted for obtaining the true number of scintillations from the counts is criticised, and the authors conclude that their own previous result is more trustworthy. It agrees much better with estimates derived from the amount of heat produced by the disintegration of radium, the difference being perhaps due, as suggested by Geiger and Werner, to energy liberated in consequence of structural alterations in the nucleus. This energy is not likely to be so large as would be indicated by Geiger and Werner's number.

THE PRODUCTION OF SULPHURETTED HYDROGEN BY FERMENTATION IN THE BLACK SEA.—Six cubic centimetres of hydrogen sulphide per litre has been found at a depth of 2970 metres in the Black Sea, and it has been suggested that this is due to the decomposition of organisms which are brought in by currents from the Mediterranean and killed by the alteration in the salinity. Sulphates in the water would also be reduced, with the formation of hydrogen sulphide. Zelinsky and Brousselovsky ascribed the phenomenon to the action of a definite organism, *Bacterium hydrosulphureum ponticum*, on the sulphate; but Nadson considers this bacterium to be an ordinary putrefactive ferment, *Proteus vulgaris*. Mr. B. Issatchenko, who gives the above particulars in an article in the *Comptes rendus* of the Paris Acad. Sci., June 23, has recently taken part in a voyage of exploration in the Black Sea, and has found a small characteristic vibrion, with all the characteristics of *Microspira aestuarii*, and probably identical with this organism. It grows abundantly under anaerobic conditions, without the presence of any albuminoid substance, in a solution containing salts of organic acids and sulphates, producing 0·3 to 0·5 of hydrogen sulphide per litre. Issatchenko considers it probable that the hydrogen sulphide in the lower layers of the Black Sea is largely due to this organism.

The Scottish Cattle Breeding Conference.

THE student of agriculture now passing through the schools is receiving an introduction to the newer sciences that have their applications in agricultural practice, but from the older generation of stock-breeders the recent advances in these fields of inquiry are completely hidden and, before their conservative indifference towards science can be overcome, much work of an educational nature must be undertaken. It was for the purpose of displaying recent achievements in the field of agricultural physiology that the Scottish Cattle Breeding Conference, held at Edinburgh on July 7-12, was convened. It was intended also to show to the breeder part of the State schemes of research in relation to agriculture in operation.

The Conference was undoubtedly an event of outstanding interest in the history of livestock breeding in Great Britain and can be accounted a success, although, as was anticipated, British breeders did not attend in large numbers. It was not to be expected that the man who regards himself as a successful breeder could easily be attracted by a scheme that had for its object the systematic collection of information that would help to make breeding successful. As the days of the Conference passed it became increasingly clear that there exists a great gulf between the scientific worker and the breeder that cannot easily be bridged. Each speaks a tongue that is foreign to the other, and the outstanding need in British agriculture to-day is the scientifically trained agricultural journalist who shall interpret the work of the man of science to the breeder. The programme was so arranged that full opportunity was given to both to learn each other's language and to see each other's point of view and methods. A great deal of time had to be spent in discussing the very A B C of genetical science, and there can be no doubt that had these hours been available for more advanced matters the Conference would have been more profitable.

The speeches of the chairman of the Board of Agriculture for Scotland, the Lord Provost of Edinburgh, the Secretary of State for Scotland, the president of the Shorthorn Society and of Dr. Robert Wallace, emeritus professor of agriculture in the University of Edinburgh, at the opening session, created just the atmosphere in which the free interchange of experience flourishes, and the stage was set for the business of the five following days.

Early in the proceedings Major E. N. Wentworth, a geneticist of repute and the present head of Armour's (Chicago) Livestock Bureau, outlined the relations between the science of genetics and practical breeding. He explained the reasons why the spectacular advances in the pure science have not been quickly followed by parallel advances in the craft, and why genetical knowledge is not likely to affect, at all profoundly, breeding procedure. The reasons are financial in nature. Genetical knowledge can best be employed in the creation and development of new breeds, but this work is made quite prohibitive because of the expense and the length of time required. It is a matter of the greatest difficulty to displace the already established even with a more satisfactory breed, and almost impossible to overcome tradition.

Major Wentworth mentioned one matter of considerable interest. The American consumer is exhibiting an ever-increasing demand for baby-beef (yearling cattle), whilst the producer, disregarding this demand and certainly fighting a losing battle, is still intent on breeding for increased size. The problem of meeting the demands of the consumer is to be tackled by the geneticist and breeder working in collaboration.

Dr. Chr. Wriedt, of Kristiania, in a paper on the inheritance of abnormal conditions, opened up a subject of profound importance to the livestock industry. During the discussion that followed it was pointed out that any characterisation, detrimental to the individual, which behaves in a mendelian fashion in inheritance is a character in the mendelian sense, and can be eradicated from a stock only by the adoption of mendelian methods of breeding. Already a considerable number of such characters that render the possessor non-viable or more or less imperfect have been recognised. Monstrous calves, deformed lambs, still-births, certain forms of sterility, of blindness, and of deafness, white heifer disease, hermaphroditism, undescended testis, skin defects, and many other conditions, have been shown to be mendelian characterisations, and it can be expected that the list will be considerably augmented when the veterinarian and the breeder recognise that the present-day knowledge of the hereditary mechanism has been gained through the study of the inheritance of similar conditions in the usual laboratory animals. It is probable that a great proportion of the anatomical defects and physiological derangements that are found in cattle will be shown to be mendelian characters.

Prof. L. J. Cole, chief of the Animal Husbandry Division of the U.S. Bureau of Animal Industry, in one of his many papers dealt exhaustively with the vexed question of the effects of inbreeding, maintaining that the harmful effects depend entirely upon the hereditary constitution of the individuals concerned and not upon any pernicious attribute of inbreeding in itself. There is a great deal of evidence which supports this contention, but the unfortunate fact remains that it is not possible for the geneticist to be really helpful in this matter. It is unwise to advise the breeder to undertake inbreeding in order to achieve rapid improvement in his stock, when the records of so many domestic breeds show that the individuals are carrying factors for harmful recessive characters which would quickly be disclosed were in breeding practised. It is true that by this method of breeding a stock could be purged of its undesirable characters, but it is equally true that during the process the stock might become extinct. In certain cases stockbreeding has become one sustained effort to retain heterozygosity in order that undesirable characters may not be expressed, and the homozygosis that follows inbreeding is the last thing that the breeder desires.

Two papers of great interest which roused great enthusiasm among the breeders were those on the reproductive functions and on the development of the udder in the cow, given by Mr. J. Hammond, of the Cambridge Institute of Research in Animal Nutrition, and these led the way to a discussion on milk-recording which was opened by a paper by Mr. B. A. Sanders, of Cambridge. The breeder was shown clearly how difficult the genetical interpretation of milk records is made by the efforts of the husbandman. Until all variations of extraneous origin are accounted for the genetical basis of milk yield cannot be begun, and even then it is to be expected that this will prove to be a very complicated multi-factor affair.

There is no doubt that shortly some modified system of advanced registry will be adopted in Great Britain in the recording of milk cattle. Mr. Mackintosh, of the National Institute for Dairying, Reading, helped

on this movement considerably by his plea for a uniform system of stating milk and butter-fat records. He pointed out that the present lack of uniformity renders comparative studies impossible, seriously embarrasses the breeding of dairy stock, and denies the overseas buyer those data to which he is entitled. He urged that the lactation period of a cow should be recorded in days; that the date of the next calving and details as to whether a full-time calf had been born should be stated; that the records of the milk-yield should be based on weighings at not more than weekly intervals and should be stated only in pounds; that the records of butter-fat should be based on a sufficient number of samples taken at fairly spaced intervals during the lactation period, and that the total weight of the butter-fat produced should be stated in pounds. The conference unanimously supported Mr. Mackintosh.

The fifth day of the meeting was given over to papers by the breeders, who were asked to define their problems. Most of the difficulties presented were such as are at the present time quite beyond genetical analysis, for they concerned highly improved expensive stock, and in many instances passed far into the realms of veterinary medicine. Nevertheless certain of the breeders' problems are problems no longer, and it was very satisfying to the geneticist to be able to explain away the lesser difficulties which still harass the breeder.

During the whole of the week the discussions were eager and the audience insatiable for information. It was shown quite conclusively that this was to be but the first of many such meetings. Before the next, however, it is to be hoped that the Journal of the Ministry and of the Board of Agriculture for Scotland, and also the series of monographs now being issued by the Ministry, will find their way into the hands of many more of the breeders of Great Britain, and that the geneticist will be co-opted on the councils of the various breed societies. F. A. E. CREW.

The Imperial Mycological Conference.

ON July 2, mycologists from all parts of the British Empire met in conference at the Imperial College of Science, South Kensington. It was the first gathering of its kind, and marks a distinct advance in organising the campaign against fungous diseases of agricultural and plantation crops. The conference was called by the Colonial Office to discuss the future arrangements for the Imperial Bureau of Mycology, but a large part of its time was taken up with interesting and useful discussions on various aspects of plant disease work throughout the Empire. Official delegates represented most of the Dominions, Colonies, and Protectorates, while the members of the Committee of the Bureau attended the meetings, as well as a number of mycologists from the British Isles who were invited to be present. On the afternoon of July 2 the delegates were entertained to tea at the Bureau, and on the evening of July 4 the British Mycological Society acted as hosts at a dinner given to the overseas mycologists in the Criterion Restaurant. The conference had been arranged to precede the Imperial Botanical Conference, which was held the following week, and the delegates had the opportunity of taking part in the meetings and excursions arranged by the latter conference.

Earl Buxton, chairman of the Committee of Management of the Bureau, received the delegates, and in his opening address spoke at length of the founding of the Bureau, the scope of its work, and the economic importance of plant diseases. The rest of this day, as well as the last part of the closing meeting, was spent on business matters.

On Thursday, July 3, under the presidency of Mr. W. Nowell, Assistant Director of Agriculture, Trinidad, Mr. Tattersfield (Rothamsted) opened a discussion on "The Co-ordination of Investigations of Fungicides," expressing the view that the explanations of fungicidal action are, in general, inadequate, and that research should attempt to correlate chemical constitution with toxic action. The subject gave rise to an animated discussion in which Dr. Brierley (Rothamsted), Mr. Dowson (Wisley), Dr. Wormald (East Malling), Mr. Briton-Jones (Long Ashton), Mr. Massey (Sudan), Mr. Nowell, Mr. Summers (Shirley Institute), and Dr. Butler (Bureau) took part, and finally the suggestion, made by Dr. Brierley, that a committee be appointed for the co-ordination of work on fungicides was referred to the Managing Committee of the Bureau for consideration. The second half of this session was occupied with the consideration of "Plant Disease Surveys in the British Empire." Dr. Butler, who introduced the subject, spoke of the many ways in which plant disease surveys are invaluable aids to the phytopathologist. Mr. A. D. Cotton (Kew) described the origin and development of the survey of England and Wales and emphasised the importance of a survey for the agricultural progress of any country. Dr. Shaw (India), Mr. Gadd (Ceylon), and Dr. Doidge (South Africa) reviewed the survey work being done in their respective countries.

In the afternoon, Dr. Pethybridge (Ministry of Agriculture) in the chair, Mr. Cunningham (New Zealand) spoke on "The Standardisation of Popular and Scientific Nomenclature in Plant Pathology." He illustrated the necessity of standardisation by a few well-chosen examples, and showed how the multiplication of common names, especially for those diseases of which the causal organisms are not known, must lead to confusion. The considerable divergence of the scientific names adopted by different workers, as well as their frequent change, is also liable to cause trouble. Mr. Cotton stated that the Phytopathological Committee of the British Mycological Society had undertaken the work of the standardisation of common names in England and enunciated the principles the committee had decided to adopt. Dr. Murphy (Irish Free State) suggested that some understanding with the United States should be reached on the subject. Various speakers mentioned the importance of the popular name in dealing with the farmer.

The next paper was one by Mr. Tunstall, of the Indian Tea Association, on "The Encouragement of Private Enterprise in the Investigation of Plant Diseases." After describing the development of the scientific department of the Association, which had more than satisfied the tea planters with the results obtained, the speaker expressed the view that continuity of the work was essential and the use of highly paid specialists for short periods unsatisfactory. The Government could encourage non-official enterprise by means of grants, and in return should have a call on the services of the enterprise. Dr. Butler spoke of the excellent work being done by private enterprise in various parts of the world, and considered that such enterprise need not clash with Government institutions. Mr. Gadd outlined the rubber research scheme established in Ceylon in conjunction with the Rubber Growers' Association. Col. French (Empire Cotton Growing Corporation) gave an account of the work of the Corporation, and Dr. Pethybridge mentioned the enterprise of the glass house industry near London in this respect.

The morning session on Friday, July 4, when Prof. J. B. Farmer (Imperial College) and later Mr. Stockdale (Ceylon) presided, was occupied wholly with diseases of tropical plantation crops. Dr. Doidge gave an account of the campaign to eradicate from South Africa the canker of citrus trees (*Pseudomonas citri*), which was probably introduced on some Japanese stocks. The cost of the campaign to date was 117,000*l.*, and though it was too early to be sure that the disease was completely stamped out, the results were promising. Various other citrus diseases were briefly reviewed. In the discussion which followed, Mr. Nowell expressed the opinion that the present campaign in South Africa, if successful, would no doubt have a considerable reaction throughout the world. Mr. Massey followed with a paper on "The Cotton Diseases occurring in the Sudan," dealing particularly with the outbreak of *Bacterium malvacearum* in that area. The disease is seed-borne, and the problem of control essentially one of seed disinfection, which is being carried out on a large scale with this year's seed. The discussion was largely concerned with this disease, but Mr. Briton-Jones (formerly mycologist in Egypt) spoke of the diseases occurring in Egypt, and Mr. Summers of the mildewing of cotton fabrics. Prof. S. F. Ashby (Trinidad) was responsible for leading the discussion on "The Panama Disease of Bananas." After an account of the disease and of the very heavy losses caused by it, especially in Central America, the speaker showed that the real solution of the problem of fighting it was the discovery of an immune variety; the work with this end in view, now in progress at the Imperial College of Tropical Agriculture, was described. Mr. Hansford described the position of affairs in Jamaica with regard to this disease. In the afternoon Mr. Bunting spoke on "The Diseases of Cacao in the Gold Coast," mentioning particularly the newly discovered cocoa parasites of that Colony.

A subject of fundamental importance was raised by Mr. Nowell, on Friday afternoon, in his paper on "The Influence of Soil Conditions on Plant Diseases." The speaker put forward the view that many diseases of plants are primarily due to soil conditions and that the fungi are only parasitic when these conditions render the hosts susceptible. Diseases of this nature could be classified as root diseases and debility diseases. Numerous examples were given, particularly root rot of sugar-cane, which has been ascribed to various fungi and which can be completely overcome by good manuring. In the vigorous discussion which followed, Mr. Tunstall strengthened the views advanced by citing additional examples from his experience of tea diseases, and Dr. Shaw spoke of the differences in the incidence of the wilt of pigeon pea on the permanent manurial plots at Pusa in India.

At the closing session of the conference on Saturday, July 5, Mr. Nowell presided, whilst Dr. Shaw and Dr. Murphy addressed the meeting on "The Application of the Results of Mycological Investigations," the former from the point of view of the tropical countries with a native population, and the latter from that of temperate countries with white farmers. Dr. Shaw described the organisation of the agricultural service in India to deal with plant diseases and the methods adopted for conveying information to the cultivator. A full discussion followed, in which Mr. Bunting, Miss Welsford (Zanzibar), Dr. Butler, Dr. Doidge, and Mr. Stockdale took part. The last part of the closing session was occupied with business matters, Sir David Prain being in the chair, and a number of resolutions were passed dealing chiefly with the establishment and finances of the Bureau, and recommending that similar conferences should be held every five years.

University and Educational Intelligence.

CAMBRIDGE.—The Research Studentship offered annually by Trinity College to a graduate of another university who intends to come to Cambridge with a view to the degree of Ph.D. has been awarded to Mr. Joseph Ratner, of Columbia University, and a teacher in the Department of Philosophy at the College of the City of New York, for research in ethics. The Dunning Scholarship, open on this occasion to prospective candidates for the degree of Ph.D., has been awarded to Mr. Lawrence St. Clair Broughall, of University College, London, for research in physics. A Dominion and Colonial Exhibition has been awarded to Mr. J. B. Williams, of McGill University, Montreal.

LEEDS.—Mr. J. R. R. Tolkien has been appointed professor of English Language. He has been Reader in English Language in the University since 1920, and has held several teaching and examining posts at Oxford and elsewhere. The institution, in the English Department of the University, of a separate Chair of English Language, is in accordance with the constitution of corresponding schools at Oxford, Cambridge, Liverpool, Manchester, and elsewhere; and indeed it restores the position which at one time obtained also at Leeds.

Dr. C. E. Gough has been appointed to the Chair of German at the University, which has been in abeyance since 1916.

Dr. S. Brodetsky has been elected the first occupant of the Chair of Applied Mathematics. He graduated as Senior Wrangler at Trinity College, Cambridge, in 1908, held the Isaac Newton Studentship for research in Mathematical Astronomy, and thereafter proceeded to the degree of Doctor of Philosophy at Leipzig. On returning to this country, he joined the mathematical staff of Bristol University in 1914, and came to Leeds in 1919 as Reader in Applied Mathematics. Prof. Brodetsky has produced a long series of papers on many branches of Applied Mathematics, and has devoted special attention to aerodynamics.

LONDON.—Dr. A. W. M. Ellis has been appointed as from October 1, 1924, to the University Chair of Medicine tenable at the London Hospital Medical College.

Dr. E. V. Appleton has been appointed as from August 1, 1924, to the Wheatstone Chair of Physics tenable at King's College. Since 1919 he has been supervisor in physics and mineralogy at St. John's College, Cambridge, of which he is a fellow, and demonstrator and lecturer in the Cavendish Laboratory.

The following doctorates have been awarded, the thesis in each case following the name of the candidate:—*Ph.D.* (*Science*): Mr. J. F. Congdon (King's College), "The Kinetic Energy of the Electrons emitted from a Hot Tungsten Filament in an Atmosphere of (*a*) Argon, (*b*) Hydrogen"; Mr. J. W. C. Crawford (Battersea Polytechnic), "Experiments on the Synthesis of Carnitine"; Mr. A. T. Fuller (Battersea Polytechnic), "Terpincol: its Resolution and Optical Properties, with a Description of some of its Derivatives"; Mr. V. G. Jolly (University College), "Platinocyanides"; Mr. M. A. Matthews (Sir John Cass Technical Institute), "Some Anthracene Derivatives"; Clara Agnes Pratt (Imperial College—Royal College of Science), "Growth Conditions of Fungi"; Mr. H. E. M. Priston (Battersea Polytechnic), "The Alcohols of the Hydroaromatic and Terpene Series: (*a*) Fenchone and the Fenchyl Alcohols, (*b*) The Esters of Borneol and Isoborneol"; Mr. E. J. Weeks (Sir John Cass Technical Institute), "Hydrogen Overpotentials in Alkaline and Neutral

olutions"; Mr. W. Clark, "On the Light Sensitivity f Photographic Emulsions"; Adela Gwendolyn rith (University College, Reading), "A Monograph n White Clover (*Trifolium repens*, L.)"; Mr. P. ewis-Dale, "An Investigation into the Nature of ne Compounds occurring in the Liquid obtained hen Oil Gas is submitted to Pressure, with Sugges- ons as to the possible Utilisation of the Liquid"; Ir. J. N. Sugden (Imperial College—Royal College f Science), "Hydration of Electrolytes and Non- lectrolytes in Aqueous Solution."

MANCHESTER.—The Council has accepted an offer om the brothers and sisters of the late Mr. Philip uckle, a former student of the University, for the ndowment, in his memory, of a scholarship in some anch of Agriculture or Zoology.

The following appointments have been made: ssociate professor of applied mathematics (for ne year), Dr. T. M. Cherry; Assistant lecturer in ngineering, Mr. J. B. M. Hay; Demonstrator in uman physiology, Miss Hilda Linford; Demonstrator n experimental physiology, Mr. E. Nevill Willmer.

SHEFFIELD.—Lord Bearsted has made a gift of 0,000*l.* to the department of metallurgy for the ncouragement of study and research.

APPLICATIONS are invited for the professorship of athology in the University of Melbourne. They hould reach the Agent-General for Victoria, Mel- ourne Place, Strand, W.C.2, by September 20 at atest. Particulars of the post may be obtained from he Agent-General.

IN the report for 1923 of the University of Adelaide, t is announced that the original University Act, which rovides that a subsidy of 5 per cent. up to 10,000*l.* .a. shall be paid by the Government on all endow- nents by private benefactors, has been amended by aising that limit to 20,000*l.* p.a., thus encouraging urther donations. The Council has agreed to assist he Medical Sciences Club in meeting the expense of ublishing a journal of experimental biology and nedical science, which is to serve as a medium for naking known the results of researches carried on in his and other universities. Work conducted in onnexion with the University's Animal Products Research Foundation included a comparison of the rowth of animals initially below the average weight vith that of animals initially above the average. The ubilee of the University is to be celebrated in 1926.

COMPLETE reform of the preparatory school urriculum seems yet a long way off. The Board of Education exercises no control over any of these chools, and, with one or two exceptions, is not nvited to express an opinion on their efficiency. Preparatory school headmasters form a close corpora- ion influenced mainly by the requirements of the Common Entrance Examination, upon the results of which scholarships to the public schools are awarded. In most preparatory schools science is regarded as an expensive luxury which brings no adequate return in the way of "successes." There are, however, a few progressive headmasters who, greatly daring, put the cause of education first. It is interesting to note that Mr. Seymour Bryant, St. Piran's, Maidenhead, has recently added a new block containing an engineering shop and drawing office, two new well- equipped dark rooms, wireless room, technical library, and music rooms. The list savours of pleasure as well as business, but this is a characteristic of a school in which the tradition of Sanderson of Oundle is followed.

Early Science at the Royal Society.

August 10, 1664. The secretary presented the society from Mr. Beal with a box full of several stones, by which the latter conceived it might be seen what is the process of the plastic spirit in shaping perfect cockles, muscles, scollops, headless serpents, fishes, thunder-stones, etc. Then was begun to be read Mr. Beal's annexed discourse relating to these stones, the rest being referred to another meeting, because Mr. Birchinsha was without, expecting to be called in, for the prosecution of the experiments with the monochord.—

Ordered—That Dr Wilkins be desired to speak to the lord Berkley, that he would please, in the name of the Royal Society, to move the committee of the company for the East Indies, that, by their interest in these parts, they would procure such answers, as may satisfy the inquiries to be sent to them; as also such particulars of the productions and curiosities of nature, as shall be specified unto them, and such others, as those parts do afford, and they by their industry can inquire for the use of the said society. Moreover, to write . . . to take special care of the transport of such things.

August 13, 1662. It was voted, That the president attended by the council, and as many of the society as can be obtained, should wait upon the King, after his coming from Hampton-Court to London, to give him humble thanks for his grace & favour: and that in the meantime the president should acquaint his majesty with their intention: and that afterwards the lord chancellor be thanked likewise, as also Sir Robert Moray, for his concern and care in promoting the constitution of the society into a corporation.

August 14, 1686. A letter was read describing the manner of transporting the great globes made for the cardinal d'Estrees by father Coronelli, designed to be presented to the French King; which manner was, that the large carts, in which they were to be carried, were placed upon low wheels, with four axle-trees, that so the wheels might be changed, at the turning of a corner, without altering the position of the case.

August 15, 1666. A letter from Dr Wallis to Mr. Oldenburg, dated at Oxford, was read, importing that whereas he had used to observe in his baroscope, that the sun-shining made the quicksilver to rise, in which the observations of others had concurred; he had this summer in the hot time of June, July and August observed the mercury constantly to rise in the night and to fall in the day. The President affirmed, that he had generally observed the contrary in his baroscope.—

The contrivance for the experiment appointed to shew, that the circular pendulum was made of two strait lines crossing one another, being fitted, as was suggested at the preceding meeting, it appeared, that the motion from the one end of the greater diameter of the circular pendulum to the same end again was equal to two vibrations of the strait line pendulum, equal in length to the former, and moving in the same plane.

August 16, 1686. A note from Mons. Justel was read, giving an account, that a french ship having lately been at the Cape of Good Hope, had been informed by the Dutch there of an expedition, which they had made towards the tropic of Capricorn; and that they had there found a nation, which answered their violins with thirty instruments, and among the rest with one, that was a sort of flute, which was made with a slit instead of holes, and a ferrel case that runs up and down upon it, according to the tone intended by it.

Societies and Academies.

LONDON.

Royal Meteorological Society, July 18 (meeting at the Rothamsted Experimental Station, Harpenden).—Mr. C. J. P. Cave, president, in the chair.—R. A. **Fisher**: Adaptation of variety to climate. One of the main problems attacked by the statistical laboratory at Rothamsted in recent years has been to ascertain numerically the effect of weather on the yield of farm crops. The Rothamsted data give the yield of wheat on thirteen plots which have been under uniform manurial treatment since 1851, and rain records from a large gauge set up in 1853. From these series of values it has been possible to evaluate the actual gain or loss of each consequent upon an additional inch of rain at any time during the harvest year. The work has involved a detailed analysis of the distribution of rainfall through the year for each year since 1853, some of the results of which are of interest. The total rainfall fluctuates greatly from year to year, but there is some evidence that the fluctuations are not at haphazard, but that at two periods centred about 1879 and 1914 there has been a prolonged spell of significantly increased rainfall. On the other hand, one feature of the rainfall distribution has shown a steady and apparently uniform change throughout the 70 years. This involves increasingly wet Decembers, and perhaps drier weather in spring and autumn. Data on this point from other stations would be of great interest.—W. B. **Haines**: A comparison of three different types of radiation recorder. This paper deals with a comparison of the readings taken at Rothamsted with three types of radiation recorder. The first of these is a recorder of the Callendar pattern, depending upon the difference in temperature between a black and a bright resistance exposed to the sky. These readings are taken as standard. The second instrument (Wilson integrator) reads the amount of alcohol or other volatile liquid which distils from a bulb exposed to the radiation into a similar shielded bulb. The third set of data is the record of hours of bright sunshine from the widely-used Campbell-Stokes apparatus. Reference is also made to a fourth set of data, that given by an evaporimeter of the porous candle type, since the readings of this instrument are correlated to the amount of radiation. A diagram made by plotting the data to suitably adjusted units brings out the following points:—(1) The alcohol integrator gives readings much too low during the winter months. The readings could be correlated for the effect of temperature upon the vapour pressure of alcohol, but there is a large random error which makes it impracticable to advance a correction formula to deduce the true radiation. (2) The hours of bright sunshine should be corrected by a factor depending upon the time of day and year (*i.e.* upon the sun's altitude). A formula deduced by Ångström from the Stockholm data, for calculating total radiation from hours of bright sunshine, is examined and found fairly satisfactory for the Rothamsted data. It is concluded that such a formula, based upon the data at one station, could with due caution be adopted for another station.

PARIS.

Academy of Sciences, June 30.—M. Guillaume Bigourdan in the chair.—A. **Desgrez**, H. **Bierry**, and L. **Lescœur**: Relation between the variations of P_H of waters containing hydrogen sulphide and their transformations when exposed to the air. The changes observed are due to two phenomena, oxidation of the sulphur causing a reduction in the P_H, and loss of carbon dioxide producing a rise in P_H.—**Recoura**: The action of acetic acid on hydrated metallic salts. Acetylated salts. Powdered crystallised copper sulphate, $CuSO_4, 5H_2O$, treated with large excess of acetic anhydride loses rapidly four molecules of the water. The fifth molecule fixes only molecule of the anhydride, and it has been proved that acetic acid is not formed. The compound produced is $CuSO_4 . H_2O . [(C_2H_3O)_2O]$. The sulphates of nickel and magnesium form similar compounds.—Alfred **Rosenblatt**: Algebraic varieties of three dimensions, the species of which satisfy the inequality $P_g \leqq (p_g - p_a - 3)$.—R. H. **Germay**: The elimination of the parameters in Cauchy's method and characteristics for the integration of partial differential equations of the first order.—Georges **Giraud**: Two formulæ applicable to the numerical calculation of integrals.—Jacques **Chokhate**: The polynomials of Tchebycheff.—Armand **Cahen**: Classification of the new continued fractions dependent on an operation $R(z)$ to one unit in excess.—E. **Gau**: Condition that a surface may be ruled by deformation.——**Gros**: Finite bending of a circular ring compressed diametrically.—Paul **Dumanois**: Experimental results on increase of compression in aviation motors. In an earlier communication, some results were theoretically deduced concerning the increased explosion pressures and thermal efficiencies of internal combustion motors when an anti-knocking compound such as lead tetraethyl, was employed. In the present paper experiments are described which confirm the theoretical conclusions. Experiments were also made to determine whether the temperature developed at the base of the pistons or at the escape valves were so high as to endanger the low melting material now employed.—Louis **Breguet**: The yield of the propulsion of birds by the motions of the wings.—Louis **Roy**: The fundamental equations of electrodynamics of continuous media in motion.—Maurice **Curie**: The photo-electric and phosphogenic effect.—L. **Riéty**: The electromotive force of filtration.—Charles **Henry**: The calculation of heats of formation and the interpretation of some exceptions to the law of maximum work.—J. J. van **Laar**: The vapour pressure of solid carbon. In a recent communication Wertenstein and Jedrzejewski have given an expression for the vapour pressure of carbon making use of Langmuir's method (evaporation in vacuum) and the Knudsen-Langmuir formula. This leads to 5050° C. (absolute) as the boiling-point of carbon. By an independent method the author arrives at 5010° C. (abs.) for the same constant. The figure 4200° C. (abs.) deduced from the measurements of Lummer and of Mlle. Kohn with the positive crater of the arc is certainly too low.—Francis **Perrin**: The role of viscosity in fluorescence phenomena.——**Bogitch**: The oxidation of chromite and the preparation of chromates. Experiments on heating chromite with various mixtures of lime and sodium carbonate, calcium and sodium carbonates, lime and common salt, lime and sodium sulphate. The influence of temperature and duration of heating were also studied.—P. **Lebeau**: The thermal fractionation of the gaseous products of the pyrogenic decomposition of some definite compounds. The author has shown that by submitting coal to progressively increasing temperatures, the curve showing the relation between gas yield and temperature is definite and constant for a given fuel. The same method has now been applied to definite compounds (starch, sugar, glucose, casein). The results appear to indicate that the method may be of value in studying organic compounds of high molecular weight.—Ch. **Courtot** and R. **Geoffroy**: The

phonation of fluorene. — MM. **Maurain, Eblé, brouste, Mouronval,** and **Escher-Desrivières**: The opagation of seismic waves in the neighbourhood of e origin. Experiments made with seismographs stalled at La Courtine, Felletin, and Ussel, recording e four experimental explosions at La Courtine.— **Diénert**: Subterranean hydrology. Details of chnique relating to the use of fluorescin and other es in tracing the path of underground waters.— dislas **Smolik**: The influence of heat on the total rface offered by the elements of the soil.—L. M. tancès: What is a hæmohistoblast?—A. **Rochon-avigneaud**: Visual lines of the central fovea (in-pendent vision) and the lateral fovea (associated sion) in the kestrel.— —— **de Luna**: The presence an accessory ovary in *Drosophila melanogaster*.— **Lecaillon**: The new races or varieties which can obtained by the method of crossing in the silkworm. (Mlle.) Lucienne **Dehorne**: Remarks on the hippia of *Daphnis longispina*.—W. **Mestrezat** and **Janet**: The dispersion of the electrolytic colloids the protoplasm in relation with the mineral trition of the cell.—Maurice **Piettre** and Clément **oéland**: Trimyristine, the glyceride of milk.—S. **utermilch**: Normal and artificial hæmolysins.

July 7.—M. Guillaume Bigourdan in the chair. H. **Deslandres**: The extension to some line spectra a property already recognised in several band ectra.—Maurice **de Broglie** and A. **Dauvillier**: omplementary researches on the Compton effect. L. **Lumière**, A. **Lumière**, and A. **Seyewetz**: Con-ibution to the study of the latent photographic nage. In experiments on the latent photo-raphic image after fixing, a developer consisting paraphenylene diamine and silver sulphite acting r 48 hours showed a gradual production of particles, hich, under a magnification of 2300 diameters, roved to be hexagonal crystals. These crystals were ot obtained when the developer was silver sulphite issolved in sodium sulphite with addition of formal-ehyde, but if a plate after exposure, fixing, and ashing were treated with an ordinary organic de-eloper, such as diamidophenol, subsequent treat-ent with the formaldehyde-sulphite of silver both eveloped the crystals.—B. **Berloty** was elected a orrespondent of the Academy for the section of eography and navigation in the place of the late lie Colin.—Marcel **Légaut**: Systems of points and he theory of skew algebraical curves.—A. **Demoulin**: urfaces of the Lie quadrics have only two char-cteristic points.—Paul **Mentré**: The projective defor-nation of certain congruences of straight lines.—Rolf **Nevanlinna**: The exceptional values of meromorph unctions.—Pierre **Jolibois** and Georges **Normand**: he decomposition of lead tetra-ethyl and its applica-ion to internal combustion motors. Pure lead tetra-thyl is decomposed at 400°, producing finely divided ead. In the cylinder of an internal combustion notor, lead tetra-ethyl would be decomposed at all ocally heated points covering these with a layer of netallic lead, thus reducing the curvature of any harp points tending to become centres of auto-xplosion.—Pierre **Idrac**: Contributions to the study f the flight of the albatross. An automatic kine-natographic apparatus was utilised in this work: it s concluded that, contrary to all hovering birds reviously studied, the albatross does not utilise scending air currents.—Alfred **Lartigue**: The co-rdination of the thermodynamical properties of water.—André **Marcelin**: Extension of the applica-ion of the gas law to superficial solutions.—L. **Vegard**: The luminous spectra of solid nitrogen and heir application to the aurora borealis and to the diffused light of the sky at night. It is shown that the aurora is probably due to the action of the kathode rays acting upon small crystals of solid nitrogen.— G. **Reboul** and **Bodin**: A new method of production of radiations in the region between the ultra-violet rays and the X-rays. Pastilles of various metallic salts are placed between two electrodes connected to a battery of small secondary cells, the fall of potential across the pastille being variable from 90 to 2430 volts. The radiation emitted is easily absorbed, capable of ionising gases, and has a wave-length between the ultra-violet and the X-rays.—Louis **de Broglie**: The general definition of the correspondence between wave and motion.— — **Lemarchand**: Equilibrium in saline double decompositions in aqueous solution.—L. **Chassevent**: The thermal phenomena which accompany the setting of plaster of Paris.—A. **Boutaric** and Mlle G. **Perreau**: A protection effect of suspensions realised by the addition of electrolytes in quantities too small to effect flocculation.—P. **Job**: The electrometric study of the hydrolysis of salts.—André **Job** and Guy **Emschwiller**: The photolysis of the organic iodides. The photochemical limit and the linkage energies. Pure ethyl iodide, in a closed system free from oxygen, on exposure to light gives free iodine and a mixture of ethylene (53 per cent.), ethane (36 per cent.), butane (6 per cent.), and hydrogen (5 per cent.). When a tube of ethyl iodide is exposed to the arc spectrum, the reaction commences only for wave-lengths shorter than 0·41 μ.—R. **Locquin** and L. **Leers**: Some new pinacolines.—Max and Michel **Polonovski**: Tautomerism of eserine.—Ph. **Négris**: The variation of composition of lavas and the temperature of the pyrosphere.—J. **Thoulet**: Local studies of the circulation of the water in the Atlantic Ocean.—L. **Petitjean**: The application of frontology to the Sahara depressions.—Filippo **Eredia**: The secondary depression of the Adriatic Sea.—Jules **Wolff**: New observations on the loss of the germinating power in the seeds of orchids.—A. **Sartory** and R. **Sartory**: The action of potassium bichromate and copper bichromate on the growth of *Phytophtora infestans*. The copper salt acts more powerfully than the potassium salt in retarding the growth of this organism.—A. **Goris**: The chemical composition of the green fruit of the vanilla and the mode of formation of the perfume of vanilla. —A. **Demolon** and Mlle V. **Dupont**: Some characters of the peat from the chalk valleys of the north of France.—Ch. **Brioux**: Saturation in the soil of sulphuric acid utilised for the destruction of weeds. After this treatment, soils originally acid or containing only small amounts of lime should be limed, or the soil will be left too acid for plant growth.—Louis **Lapicque**: The theory of latent addition.—Boris **Ephrussi**: The segmentation velocities of the egg of the sea-urchin.—F. **Vlès** and A. **de Coulon**: The relations between the state of the organism and the physico-chemical properties of muscular substances. —Jules **Auclair**: The probable cause of the natural immunity of birds towards human tuberculosis and its application to the digestion of the Koch bacillus in the organism of the guinea-pig. A substance has been extracted from the organism of the pigeon, chicken, duck, goose, and turkey which, as extracted, is without action on the Koch bacillus. Under well-defined conditions this substance can be converted into another capable of digesting the tubercle bacillus. No tuberculosis developed in guinea-pigs, if this substance and the Koch bacillus were injected together. No details of the method of extraction, nature of the substance or mode of after-treatment are given.— L. **Hugounenq** and J. **Loiseleur**: The catalytic action exercised by some colloids, more particularly by glycogen, in the hydrolysis of the albumens.

CAPE TOWN.

Royal Society of South Africa, May 21.—Dr. A. Ogg, president, in the chair.—R. F. **Lawrence**: South African spiders. Several genera of South African Thomisidæ illustrate imitations of the calyx, leaves and leaf-axils of flowers and the stems of reeds and grasses. Runciniopsis is much flattened and lies pressed against the stems of grasses, while the straw-coloured form Monoeses has the abdomen elongated into a long cylindrical caudiform process and escapes observation by remaining motionless amongst grass or thin reeds.—F. G. **Cawston**: The smaller South African shells that harbour Cercariæ.—F. E. **Fritsch** and Florence **Rich**: Contributions to our knowledge of the Freshwater Algæ of Africa, V. On a deposit of diatomaceous earth from Ermelo, Transvaal. This deposit occurs as a pan, about half a mile long and 440 yards wide, on the farm Bank-Plaats, and is still being formed. During the wet season, water percolates through the deposit, and living diatoms are found on its surface; in the dry season these mostly die off, and their siliceous valves form the deposit. Seventeen species of diatoms occur in it; one of these is new, and several new varieties are also described and figured.

MELBOURNE.

Royal Society of Victoria, March 13.—Prof. T. H. Laby in the chair.—A. M. **Lea**: On some new Australian Chrysomelidæ.—F. **Chapman** and F. A. **Singleton**: A revision of the Kainozoic species of Glycymeris in Southern Australia. Three new species are here described, namely, *G. gunyoungensis* (Balcombian and Janjukian), *G. ornithopetra* (Janjukian), and *G. planiuscula* (Kalimnan and Werrikooian). An example of the type referred by McCoy to "*Pectunculus*" *laticostatus* shows that two species were represented. The species described by Johnston as "*Pectunculus*" *maccoyi*, from Table Cape, is apparently confined to that locality, and all Victorian records under that name are here referred to other Victorian species. On broad lines the phylogeny of the group in two main series can be traced, linking the early Kainozoic with the living species.—H. **Ashton**: Notes on the Gippsland hairy cicada, *Tittigarcta crinita*, Dist. This insect, unlike the other Cicadidæ, is probably nocturnal, as it flew late in the evening and early in the morning, and was not seen during the day, hiding under bark. The species is not so uncommon as the small series in the various museums would suggest, as on the evidence of the nymphal cases very many must emerge during the season. The specimens were caught close around the Hotel Kosciusko, and are the first recorded from New South Wales.—G. F. **Hill**: Notes on Australian mosquitoes, with descriptions of their early stages.—H. W. **Wilson**: Studies on the transpiration of some Australian plants, with notes on the structure of their leaves. So long as the available water supply was adequate, the transpiration rate increased with the temperature to the limit of the transpiring power of the plant and increased very rapidly when the temperature rose above normal. The highest transpiration rates recorded in grams per sq. metre per hour for the two hottest days of observation were:—*Eucalyptus botryoides*, 750 gm. between 12 and 2 P.M.; *E. cladocalyx*, 640 gm. between 12 and 2 P.M.; *Casuarina Luehmanni*, 525 gm. between 2 and 3 P.M. Strong wind increased the transpiration of such plants as *E. cladocalyx* and *Casuarina Luehmanni*. The acacias were affected very little, while in other species the transpiration was quite disorganised. Stomata were studied in their relations to transpiration. The number per sq. mm. of transpiring surface var *Hakea gibbosa* with 70, and *Myoporum insulare* 80 had the lowest record, while *Casuarina Luehm* with 500, *Eugenia Smithii* with 540, and *Ver Dieffenbachii* with 610 had the highest ave records. The highest records of stomata 1030, 970, and 960 per. sq. mm. on some juv leaves of *Eucalyptus globulus* and 740 on some le of *E. cladocalyx*. The size of the stomata v from 52 × 36 microns (outside measurements *Hakea gibbosa*, and 70 × 65 microns in the adul *alpina*, to 18 × 16 microns on the juvenile leav *E. maculata* var. *citridora*. The so-called xerop plants of Australia are provided with a high ave number of stomata which enables their transpir rate to respond quickly to changes of tempera and water supply, and they are well protecte their tough outer coverings, in some cases assiste glands, from injurious loss of water.

SYDNEY.

Linnean Society of New South Wales, April Mr. R. H. Cambage, president, in the cha W. F. **Blakely**: The Loranthaceæ of Australia (P Six species were described as new.—G. H. **Cunning** A critical revision of the Australian and New Ze species of the genus Secotium. Sixteen specie discussed, fourteen of them being confine Australasia. Five species are described as new **Brough**: Studies in the Epacridaceæ. i. The history of *Styphelia longifolia* (R.Br.). An exp tion of the structure and mechanism of dehiscen the anther is given, and megasporogenesis is descri the micropylar megaspore functions, in place o usual chalazal one. All three non-functional n spores persist in an active state until endos formation is almost completed. This phenom has not previously been recorded in the life-hi of the Angiosperm. The persistence of the functional megaspores evidently represents th tention of an ancestral condition, but the presen function seems to be haustorial.—Marguerite **He** A monograph of the freshwater Entomostraca of South Wales. Pt. iv. Phyllopoda. Nineteen sp are given, six of which are described as new, three others are recorded for the first time from South Wales and one from Australia.

Official Publications Received.

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Supplement to NATURE

No. 2858 AUGUST 9, 1924

Prevention of Disease.[1]

By Major-General Sir DAVID BRUCE, K.C.B., F.R.S., A.M.S., President of the British Association.

THIS is the fourth time the British Association for the Advancement of Science has met in Canada rst in 1884 in Montreal, in this city in 1897, and in nnipeg in 1909. The addresses given on these asions dealt with the advancement of knowledge in hæology and physics. It is now my privilege, as a mber of the medical profession, to address you on advances made during the same period in our owledge of disease and our means of coping with l preventing it.

An address on the prevention of disease at first sight es not promise to be a very pleasant subject, but, er all, it is a humane subject, and also a most im- rtant subject, as few things can conduce more to man happiness and human efficiency than the ad- ncement of knowledge in the prevention of disease. ink for a moment of the enormous loss of power in community through sickness. Some little time ago e English Minister of Health, when emphasising the portance of preventive work, said that upwards of ,000,000 weeks of work were lost every year through kness, among insured workers in England. In other rds, the equivalent of the work of 375,000 people r the whole year had been lost to the State. When that is added the corresponding figure for the non- sured population you get some idea of the importance preventive work.

Another way of estimating the value of prevention in terms of dollars, or pounds, shillings, and pence, nd it has lately been calculated that the direct loss England and Wales from sickness and disability mounts to at least 150,000,000*l.* a year. In the nited States, with a much larger population, the loss put down at 600,000,000*l.*

Another reason why this is an important subject is hat medicine in the future must change its strategy, nd instead of awaiting attack must assume the ffensive. Instead of remaining quietly in the dressing tations and field hospitals waiting for the wounded to our in, the scientific services must be well forward in he enemy's country, destroying lines of communica- ion, aerodromes, munition factories, and poison-gas entres, so that the main body of the army may march orward in safety.

It must no longer be said that the man was so sick he had to send for the doctor. The medical practitioner of the future must frequently examine the man while he is apparently well, in order to detect any incipient departure from the normal, and to teach and urge modes of living conformable to the laws of personal health, and the Public Health authorities must see to it that the man's environment is in accordance with scientific teaching. It may be a long time before the change is widely accepted, but already enormous advances have been effected, and it only depends on the intelligence and education of the populations how rapid the future progress will be. Public opinion must be educated to recognise that most diseases are preventable and to say with King Edward VII., "If preventable, why not prevented?"

To our forefathers disease appeared as the work of evil spirits or magicians, or as a visitation of Providence to punish the individual or the community for their sins. It is not my purpose to give a detailed account of the first strivings after a better knowledge of the causes of disease, but it may be said the new era began some few hundred years ago, when it was recognised that certain diseases were contagious. For a long time it was held that this contagion or infection was due to some chemical substance passing from the sick to the healthy, and acting like a ferment; and then, about the middle of last century, the idea gradually grew that microscopic creatures might be the cause.

About this time it had been discovered that the fermentation of grape juice was caused by a living cell and that certain contagious skin-diseases were associated with living fungi. Things were in this position when there appeared on the scene a man whose genius was destined to change the whole aspect of medicine; a man destined to take medicine out of the region of vague speculation and empiricism, and set its feet firmly on new ground as an experimental biological science. I mean the Frenchman, Louis Pasteur. It is from him we date the beginning of the intelligent, purposive prevention of disease. It was he who established the germ theory, and later pointed the way to the immunisation of man and animals, which has since proved so fruitful in measures for the prevention or stamping out of infectious diseases. I need not discuss his life and work further. His name is a household

[1] Inaugural address delivered to the British Association at Toronto on August 6.

word among all educated and civilised peoples. Every great city should put up a statue to him, to remind the rising generations of one of the greatest benefactors of the human race.

What the change in medicine has been is put into eloquent language by Sir Clifford Allbutt: "At this moment it is revealed that medicine has come to a new birth. What is, then, this new birth, this revolution in medicine? It is nothing less than its enlargement from an art of observation and empiricism to an applied science founded upon research; from a craft of tradition and sagacity to an applied science of analysis and law; from a descriptive code of surface phenomena to the discovery of deeper affinities; from a set of rules and axioms of quality to measurements of quantity."

With one notable exception, the medical profession were not quick to see that Pasteur's discoveries of the nature of fermentation and putrefaction had a message for them. This exception was Joseph Lister, who had been for some years endeavouring to comprehend the cause of sepsis and suppuration, which commonly followed every surgical operation and most serious injuries involving a breach of the skin. When, in 1865, Lister read Pasteur's communication upon fermentation, the bearing of the discovery on the problems which had so earnestly engaged his attention was apparent to him. He inferred that suppuration and hospital gangrene, the causes of which had so far baffled his imagination, were due to microbes introduced from the outside world, from the air, and by instruments and hands of the operator. Remember, this was years before the microbial causation of any disease was established.

To test the correctness of his inference, Lister proceeded to submit all instruments, ligatures, materials for dressings, and everything that was to come directly or indirectly into contact with the wound, the hands of the operator, and the skin of the patient, to treatment with chemical disinfectants. The satisfactory results which followed this practice astonished even Lister, and he spent the rest of his active life in improving and simplifying technical methods of preventing the ingress of microbes to wounds, and in convincing his professional brethren of the truth of the conclusions based on this work of Pasteur.

Infectious Diseases—(A) Bacterial.

As soon as it was recognised that infectious diseases are caused by living germs, a wave of enthusiasm swept through the medical world, and it was not long before the causation of many of the most important of them was discovered. I need not give a full list of these, but at or round about the time of the first meeting of the British Association in Canada the micro-organisms of tuberculosis, typhoid fever, Malta fever, cholera, malaria, diphtheria, tetanus, and others had b discovered and described.

But it must not be assumed from what has been s that all the most important diseases are caused living germs. Many of the ills that afflict mankind due to quite other causes—alcoholism, for exam or the deficiency diseases, due to the absence deficiency in our diet of some substance essential proper growth and development. Rickets, one of greatest scourges of industrial communities, is mai a deficiency disease. It is reported that as many 50 per cent. of the children in the slums of some of big cities suffer from the effects of this disease. Th again, there is the whole series of diseases or conditi due to defective or excessive action of our own inter glands. Added to these, and perhaps the great scourge of all, there is the immense amount of chro ill-health and actual disease caused or promoted by unhealthy conditions found in our large cities, due bad housing and overcrowding—the so-called disea of environment.

Malta Fever.

To return to the infectious diseases. After the livi germs or parasites causing them had been isolated, t process of prevention was soon begun. The metho employed were varied, and I may illustrate one of t simplest by relating briefly the history of the preventi of Malta fever, with which I was myself, to so extent, associated. Malta fever is really a widespre disease, although it is called by a local name. It found all round the Mediterranean, throughout Afri as far south as the Cape Province, in India and Chin and even in some parts of America. It was very pr valent in Malta in the old days, and rendered the isla one of the most unhealthy of all our foreign milita stations. When I arrived in Malta, in 1884, I four that every year, on an average, some 650 soldiers a sailors fell victims to it, and, as each man remained an average 120 days in hospital, this gave the hu total of about 80,000 days of illness per annum fro this fever alone.

The British had held Malta since the beginning last century, and, although much attention had bee given to the fever and its symptoms had been full described, no advance was made towards its preventio until 1887, when the living germ, the *Micrococc melitensis*, causing it was discovered. At this time good deal of work was expended in studying the natur history of the fever and the micrococcus, but all to n purpose. Nothing was discovered to give a clue t any method of prevention. At the Naval Hospit especially everything in the way of prevention wa done that could be thought of: the water supply an drainage were thoroughly tested, the walls were scrape and every corner rounded off where dust might li immaculate cleanliness reigned; but all these pre

tions proved useless. Almost every sailor who ıe into the hospital even for the most trivial com- ınt took Malta fever, and after a long illness had to invalided to England.

'hings remained in this very unsatisfactory state for enteen years, until 1904, when the Admiralty and r Office, alarmed at the amount of sickness and aliding in the Malta garrison, asked the Royal iety of London to undertake the investigation of fever. This was agreed to, and a Commission was ordingly sent out in the same year and remained at rk until 1906. During the first year every likely of approach was tried. A careful study was made to how the micrococcus entered the body, how it left body, its behaviour outside the body, its patho- ıic action on various animals; but still no indication a method of prevention showed itself. Next year, wever, in 1905, the problem of prevention was ved, and that by the merest of accidents.

In the previous year experiments had been made :h the object of finding out if the goat, among other imals, was susceptible to the disease. The goats in lta, which supply all the milk, are very much in idence, as they are driven about in small herds and lked as required at the doors of customers. Several ats had been injected with cultures of the micro- :cus, but, as they showed no rise of temperature or y signs whatever of ill-health, they were put aside being immune or refractory to the disease and thing more was thought about them.

In the spring of 1905, about six months after these periments had been made, Dr. Zammit, a Maltese mber of the Commission, who had kept one or two of ese goats, happened for some reason or other to amine their blood, and found that it clumped or glutinated the micrococcus. This was strange, and emed to show that, although the micrococcus had t caused fever or any signs of illness in the goats, it ust have lived and multiplied in the tissues of these imals in order to have brought about this change in e blood. This observation led to the re-examination the immunity of the goat, when the extraordinary scovery was made that about 50 per cent. of the goats the island were affected by this disease, and that 10 r cent. of them were actually excreting the micro- ccus of Malta fever in their milk. Monkeys fed on ilk from an affected goat, even for one day, almost variably took the disease.

Thus the weak link in the chain of causation had been und. The military authorities struck Maltese milk ut of the dietary, and replaced it by an imported ariety, and from that day to this there has scarcely een a case of Malta fever in the garrison. Malta, om being the most unhealthy of foreign stations, ecame a health resort, and was in fact used as a anatorium during the late War. The disease had been blotted out at a single blow. This, then, is one way of preventing an infectious disease; that is to say, by the discovery of the living germ, the study of its natural history, and so to a means of stopping it reaching its victim, man. This is the best way of prevention: shutting the stable door before the horse is stolen.

Typhoid Fever.

There are, however, other ways of preventing bacterial diseases. Let us take, for example, a method widely used in the prevention of typhoid fever. The fundamental and sound way of attacking this disease is by ordinary hygienic measures, especially a good water supply and good drainage. It is therefore one of the first duties of those in power to see that their people have, in addition to houses with plenty of light and air, a good water supply and a good drainage system, and money cannot be spent to better advantage than in the attainment of these three essentials to health.

When typhoid fever is rife in a community, it means that there is either a contaminated water supply or a faulty drainage system, and the municipal authorities ought to be called to account. In England, owing to improved sanitation, cases of typhoid fever are fifteen times less than they were fifty years ago.

It is not always possible to ensure good hygienic surroundings—for example, among troops on active service. It is therefore legitimate under certain conditions, and especially in time of war, to practise a less sound, a less fundamental, method of prevention, and this second method is known as inoculation or vaccination. In order to understand how this acts, let us consider, for a moment, what takes place in a man's body when he is attacked by the typhoid bacillus. Everybody knows that the bacillus gives rise to poisons or toxins which cause the fever and other symptoms. But the cells and tissues of the man are not passive under the attack. They at once begin to fight against the infection, by forming substances in the blood to neutralise these toxins, hence called antitoxins or anti-bodies, and their function is finally to destroy the invading germs. If the man recovers, he is immune from a further attack by the presence of these antibodies in his blood. He has become immune by passing through an attack of the disease.

This is the foundation of the second way of preventing infectious diseases. Speaking broadly, it means that you subject a man to a mild attack of the fever in order that his blood and tissues will respond to the stimulus by producing antibodies. This method takes its origin and name from that of vaccination against smallpox. Jenner solved that problem by the accidental discovery of vaccinia, a form of smallpox attenuated or weakened by passage through another species of animal. This weakening of the virulence of a micro-

organism by passage through another kind of animal is by no means uncommon in Nature.

Pasteur, following on these lines, conceived the idea of weakening or attenuating the virulence of the living bacilli by artificial means, so as to give rise to a mild attack of the disease, and in this way to render animals immune. This he did with marked success in anthrax and chicken cholera.

The next forward step in this method of preventing disease was made by Haffkine, a pupil of Pasteur, who about the year 1894 produced a vaccine against cholera, and a few years later another against plague. In the course of this work it was discovered that it was not necessary to use living cultures of the bacilli, but that vaccines made up of dead bacilli had much the same effect. This substitution of the dead bacilli for the living was a great advance in the method, being much simpler and much safer.

The next disease to be attacked by this method was typhoid fever. This was initiated by Sir Almroth Wright at the British Army Medical School, and carried out with that investigator's characteristic ability and energy. The method was mainly directed in the first place to lessen the mortality from this disease among our soldiers serving in India. After several years' experience, the mode of inoculation which was finally settled on was to give two injections of dead typhoid bacilli, one of 500 millions, and a second, at an interval of ten days, of a thousand millions.

Now let us see what effect anti-typhoid inoculation has had on the prevention of typhoid fever among our soldiers in the field. In the South African War, at the beginning of the century, before the method had been developed, in an army the average strength of which was only 208,000, there were 58,000 cases of typhoid fever and 8000 deaths. In the Great War, on the Western Front, with an average British strength of one and a quarter millions, there were only 7500 cases and 266 deaths. In other words, there were fewer cases of the disease in this War than there were deaths in the South African.

It is also interesting to learn from French sources that at the beginning of the War the French soldiers were not inoculated, whereas the British were. The result for the first sixteen months was striking. During this time the French had some 96,000 cases, with nearly 12,000 deaths. The British had only 2689 cases and 170 deaths. Afterwards the French soldiers were very thoroughly vaccinated, with the result that their immunity eventually became as striking as our own.

What the number of cases and death-rate from typhoid fever might have been in the huge armies fighting on the different fronts had it not been for this preventive inoculation it is impossible to say, but undoubtedly the suffering and loss of life would have been enormous. I may therefore conclude this account of anti-typhoid inoculation by saying that it certa constituted one of the greatest triumphs in the prev tion of disease during the recent War.

Tetanus and Diphtheria.

I shall now pass on to consider a third method preventing bacterial diseases which has also b evolved during the time under review; that is, by injection of specially prepared blood sera. These known as antitoxic sera, and the most familiar examp are anti-tetanic and anti-diphtheritic.

We have seen how the injection of living or de bacilli or their toxins into animals gives rise to t production of antibodies or antitoxins. The blo serum of such animals in virtue of the antibod contained in it can be used to combat disease. I us take in the first place the case of tetanus, ur recently considered to be one of the most fatal maladies, at least 85 per cent. of the cases succumbi As you are aware, anti-tetanic serum is prepared injecting horses with large quantities of tetanus tox When the blood is as full as possible of antibodies, is drawn off and the serum allowed to separate out.

The idea lying behind this third method of p venting disease is to pour in these ready-made an toxins in order to assist the body in its first strug with the invading disease, and give it, as it were, breathing space to prepare its own defences. Natura the immunity produced by these antitoxic sera is o passive nature and of short duration, as compar with that produced by the disease itself, or even the milder form brought about by vaccination inoculation. Anti-typhoid inoculation will protect soldier for, let us say, two years; anti-tetanic ser will protect for only a week or ten days. It is the fore impossible to inoculate a whole army agai tetanus. It is necessary to wait until there is a dan of the disease occurring.

To illustrate this I shall describe briefly the hist of the prevention of tetanus during the Great W When the British Expeditionary Force went over France in August 1914, only a small quantity of an tetanic serum was taken, and that for the purpose treatment rather than prevention. But shortly af the outbreak of hostilities, the number of cases tetanus among the wounded became so alarming th no time was lost in grappling with the danger. La quantities of serum were hurried to the front, a some two months after the beginning of the War it w possible to make an order that every wounded m should receive an injection of anti-tetanic serum soon after he was wounded as possible. Later after further experience had been gained, the sin injection was increased to four, given at intervals o week. This helped the wounded man over the dang ous time, and the results were very successful.

in August and September 1914, before the prolactic injection was given, roughly speaking, nine ten out of every thousand wounded were attacked tetanus, and some 85 per cent. of these died. After anti-tetanic injections had been introduced, the idence fell to little more than one per thousand, the mortality to less than half. To put the matter adly: during the War there were 2500 cases of anus in the British Army, with 550 deaths. If re had been no prophylactic injection of anti-tetanic um, there would probably have been 25,000 cases h 20,000 deaths—a very striking example of the ent development in the prevention of disease.

Another very important and widespread disease, newhat resembling tetanus, is diphtheria, and there no better example of the advance of science in thods of cure and prevention than is found in this ease. Thanks to the work of Klebs and Löffler in early 'eighties and, some years later, to the brilliant earches of Roux and Yersin, the causation and tural history of this disease were very thoroughly cidated. Anti-diphtheritic serum is prepared much the same way as the anti-tetanic. By the repeated ections of gradually increasing doses of the bacilli their toxins, a serum is produced which has a marked rative effect in cases of diphtheria. It is stated that e introduction of anti-diphtheritic serum in 1894 s reduced the death-rate from 40 to 10 per cent., d if used on the first day of the disease to almost *nil*.

The serum is essentially a curative agent and is eful only to a limited extent in prevention. But ely essentially preventive measures in diphtheria ve come into vogue. The procedure employed is bring about an active immunisation by a mixture toxin and antitoxin in individuals who have been own to be susceptible to the disease by what is own as the Schick test. In the United States, a mpaign on these lines has been begun against this sease which promises brilliant results. It is confidently ated that by their new measures there is a possibility robbing diphtheria of all its powers to kill or injure.

The mode of prevention of these diseases—Malta ver, typhoid fever, and tetanus—illustrates the three incipal methods of preventing bacterial diseases: Malta fever, by getting down to bed-rock and pping the disease at its source; in typhoid fever, giving, as it were, a mild attack of the disease, by ccination or inoculation, so as to bring about a eater power of resistance; in tetanus, by pouring antitoxins, already prepared in the serum of another imal, in order that they may neutralise the toxins the invading bacilli as soon as they are formed.

Tuberculosis.

There are other important bacterial diseases, however, which cannot be attacked so simply. For example, there is tuberculosis, a disease distributed over the whole world and one of the greatest scourges of civilised communities. It is a disease which has been known from time immemorial, but it is only within our own time that the bacterial cause has been recognised. I can well remember a day in 1882 when I met a fellow student who had just returned to Edinburgh from Germany. He told me that it had been recently discovered that the disease was really caused by a living germ, the tubercle bacillus. It was difficult at first to believe such a revolutionary idea, but such was the interest and excitement raised that many workers at once took up the study of the subject, and in a short time the truth of Koch's great discovery was fully proved. This was a magnificent example of research work, most admirably, carefully, and completely carried out, and placed Koch at once in the front rank of scientific workers.

Before Koch's discovery a good deal had been done in the way of prevention. Before all things, this disease is a disease of environment. Its birthplace and home is the sunless, ill-ventilated, overcrowded room. The late Prof. Edmund Parkes, Professor of Hygiene at the Army Medical School, reduced to a great extent the incidence of tuberculosis in the British Army by procuring for the soldier more floor-space and more air-space in his barracks. It is related of General von Moltke that when he heard of the death of Parkes he said that every regiment in Europe should parade on the day of his funeral and present arms in honour of one of the greatest friends the soldier ever had.

The prevention of tuberculosis is thus seen to depend fundamentally on the provision of a better environment and the education of the people in physiological living. To attain this in the older civilisations will be a hard task, entailing enormous expenditure of money and energy. In the Report of the Royal Commission on the Housing of the Industrial Population of Scotland in 1917 is described the unsatisfactory sites of houses and villages, insufficient supplies of water, unsatisfactory provision for drainage, the gross overcrowding in the congested industrial towns, occupation of one-room houses by large families, groups of lightless and unventilated houses in the older burghs, clotted masses of slums in the great cities—a terrible picture, the heritage of the age of ignorance, internal strife, and walled towns.

The people of new countries should see to it, and doubtless will see to it, that these old evils are not perpetuated. As Sir Robert Philip, Professor of Tuberculosis in the University of Edinburgh, has eloquently said: "Were it possible to begin afresh the scheme of civilised life, were it possible to undertake anew the creation of cities and the homes of our people, were it possible to place within the recreated dwellings an

understanding race, detuberculisation might be quickly attained. What a magnificent opportunity for the builders of the new cities, the moulders of fresh civilisations, with the grand purpose of 'No tuberculosis.' The architect, the sanitarian, and the citizen would agree in insisting that physiological laws should be paramount, that there should be effective obedience to the larger demands of hygiene in the home, the school, the workshop, the meeting-place and the cow-shed. Mankind was born into air and sunlight: these are his natural heritage. They are more—they are the irreducible conditions of life."

In regard to the tubercle bacillus it is so widespread, so ubiquitous in civilised communities, passing from one infected host to infect another, that it would seem impossible under existing conditions to prevent its spread. At present it is taught, and on what seems good evidence, that the majority of the population of our crowded cities has at one time or another been attacked by this disease. But in every hundred men who die in England, only about ten die of tuberculosis, which shows that a large percentage of the population successfully resists the tubercle bacillus. When this occurs it means that the person attacked possessed powers of resistance which enabled him either to destroy the invading bacilli or deal with them so as to render them harmless.

A point of importance in this connexion is that it has recently been demonstrated that the disease is usually acquired in childhood. The fact is of capital significance, for if the disease is recognised sufficiently early, and the child is placed under good hygienic conditions, there is a very good chance of effective resistance and immunity against a second attack being set up. The present evidence goes to show that the presence of latent tubercle prevents a second invasion. If further outbreaks take place, they would seem to be due to a flaring up of the old latent tubercle rather than to a fresh infection. Metchnikoff studied the question in a remote part of Siberia where the tubercle bacillus was unknown. He states that very many of the young men and women who migrated from this clean country into the big cities died of acute and rapid tuberculosis, on account of not having been exposed to infection in their childhood.

The experience of Colonial troops in the late War is instructive. Thus, in France the Senegalese, who are almost without tuberculosis in their native condition, and were found to be free from tuberculosis on reaching France, developed in large numbers an acute and fatal form of tuberculosis in spite of the hygienic measures enforced by the Army authorities. This raises a curious point. If it were possible for any country to clear itself of the tubercle bacillus, it would appear to be incurring a great risk for an inhabitant to migrate into any neighbouring country. But, in spite of this, it is the duty of medical men to keep in check, as far possible, the ravages of the disease.

The preventive measures against tuberculosis at t present time are, in the first place, improvement in t general hygienic conditions. Thereby individual resi ance—and communal resistance—can be remarkal increased. In the second place, as every case of tub culosis must arise from a previous case, either human bovine, it is very necessary that methods of ea diagnosis, preventive treatment, and segregation of t more infective types should be employed. This is do by the setting up of tuberculosis dispensaries, c committees, sanatoria, hospitals and colonies. Th several elements are combined in the model Tub culosis Scheme which is now universal throughout Gr Britain. In the third place, much can be done anticipate and limit the progress of infection by t use of tuberculin, but caution is required in assessi the claims, sometimes hasty and extravagant, advanc by adventurers in this field of research.

Many other points might be brought forward, b the subject is such a vast one that I must conte myself with directing attention to the importance o sound milk supply. The contamination of our ho herds with tuberculosis is so great that no pains shou be spared to secure a safe milk supply, and I und stand that the city of Toronto is a model in this respe

The result of these methods of prevention agai tuberculosis may be given briefly. Sir Robert Phi writes that in Scotland ten years before Koch's d covery the death-rate from this disease was 404 p 100,000; in 1920 it had fallen to 124 per 100,000, a f of 69·3 per cent. He also points out that the "rec acceleration of rate of reduction which is noticeal in England and Scotland is of arresting interest. Scotland the acceleration of fall in the mortality r likewise arrests attention. Thus, during twenty ye up to 1890, the percentage fall in mortality from forms of tuberculosis was 35, while during twenty ye from 1900 to 1919 the percentage fall was 45."

This is very satisfactory, and has only been arriv at by hard work on the part of medical men, nurs and voluntary workers. Any tuberculosis schem however perfect in theory, will require untiring ener patience, and perseverance to bear fruit. On this si of the Atlantic, in the United States, these an tuberculosis schemes have been pursued with e thusiasm, with the result that Washington in 1920 h a death-rate, from all forms of tuberculosis for 100,0 of the population, of only 85, Chicago 97, and New Yo 126. London in the same year had a death-rate 127, practically the same as New York. Other natio have not been so energetic in preventive measur Vienna having in 1920 a death-rate of 405, and Pa 279 per 100,000 from the same cause.

It is evidently the duty of every nation to take

ns against a disease which exacts such a terrible toll leath, suffering, and inefficiency. If this were done h energy and enthusiasm it is not too much to hope t in a few generations the tubercle bacillus would be ctically brought under control, and with it many er malign influences.

Infectious Diseases—(B) Protozoal.

I shall now pass on to the consideration of the second at group of infectious diseases, the Protozoal, and sider what methods of prevention have been found olicable to them.

The scientific study of the protozoal diseases of man y be said to have begun with the epoch-making covery of the malaria parasites in 1880 by the istrious Frenchman, Laveran; next, in 1893, the covery by Theobald Smith and Kilborne of the cause Texas fever and the part played in its dissemination the cattle-tick; in 1894 the discovery of the trypnosome of nagana and its intermediate insect host te tsetse-fly; in 1898 the working out of the development of the malaria parasite of birds in the mosquito Ronald Ross, greatly aided and abetted in the work Patrick Manson, which led, through the work of Grassi and his fellow-workers in Italy, to the final olution of the malaria problem. A year later the imrtant discovery of the mosquito carrier of yellow ver was made by the American Army Commission, der the directorship of Reed, and in 1903 Leishman nounced his discovery of the protozoal cause of la-azar.

These protozoal diseases are world-wide, like the cterial, but it is in the warmer climates that their ect is most felt. The great plagues of the tropics, ch as malaria, amœbic dysentery, kala-azar, and eeping sickness among men, Texas fever, tsetse-fly sease, and others among domestic animals, are caused minute microscopical animal parasites. Large acts of country have been and are still rendered unhabitable to white settlers by their presence. The bening up of Africa, for example, was rendered difficult the tsetse-fly, before the advent of railways. No oner had an expedition started for the interior than e fly attacked the cattle transport, and before long e expedition had to make its way back as best it uld to its base on the coast. The only way to get to the country was on foot with native porters.

The protozoal diseases of domestic animals have also d to enormous loss in all parts of the world. Texas ver, or red-water, has swept whole countries of their ttle. After the Boer War, South Africa was devastated by the introduction of East Coast fever, nother protozoal disease of cattle closely related to exas fever. How is the prevention of these diseases be brought about? We find that up to the present ttle can be done by way of vaccination or inoculation or by the use of anti-sera as in the bacterial diseases. On studying the natural history of these protozoal parasites, however, it is found that many of them depend on an intermediate insect host for their continued existence, and it is by taking advantage of this characteristic that methods of prevention can be devised. To illustrate this I might cite the classical examples of malaria and yellow fever, but, as these must be familiar to you all, I shall take instead the trypanosome diseases of Africa, the best known of which are sleeping sickness in man and nagana or tsetse-fly disease in the domestic animals.

Nagana or Tsetse-fly Disease.

In 1894, a year after Theobald Smith and Kilborne had published their famous monograph on Texas fever, a severe epidemic among native cattle in the north of Zululand was reported to the Natal Government. The disease was called nagana by the natives, and it is curious that there was no suspicion at the time that it had any connexion with the tsetse-fly. At this time a very enlightened administrator, the late Sir Walter Hely-Hutchinson, was Governor of Natal and Zululand, and it was due to him that the investigation of the cause of the Zululand outbreak was at once undertaken. As I happened to be stationed in Natal at this time I was chosen to undertake the work, and at once started on the long journey, mostly by ox-wagon, to the scene of the outbreak.

On examination of the blood of the nagana cattle, a minute active flagellated protozoal parasite, belonging to the genus Trypanosoma, was discovered, and after many experiments on dogs, horses, and cattle it was decided that in all probability it was the cause of the disease. Trypanosomes had previously been described in the blood of rats and horses in India by Timothy Lewis and Griffith Evans, but nothing was known as to the mode of their transmission from animal to animal.

It seemed as if the discovery of the nagana trypanosome would have ended the investigation in Zululand without any means of preventing the disease being discovered, but another observation made at this time threw more light on the subject. In the low country, between the high ground on which the nagana camp was situated and the sea, there happened to be a so-called "Fly belt." Every schoolboy had read about the tsetse-fly in books of travellers and hunters, especially in those by the most famous of them all, David Livingstone the missionary, and out of curiosity I decided to find out what happened when an animal was bitten by the fly, or, as it was termed, fly-struck. Natives were therefore sent with cattle and dogs into this "fly country," with orders to form a camp and expose the animals to the bites of the fly. This was done, and it was with great surprise that on their

return to the hill the blood of these fly-struck animals was found to contain the same parasite as that found in the nagana cattle.

Nagana and tsetse-fly disease were finally proved to be identical. The tsetse-fly disease was shown to be caused, not, as had been believed, by the poisonous bite of the fly, but by the transference of a protozoal parasite from the fly to the animal in the act of sucking blood. Now the question arose as to where the fly found the parasite. As the tsetse-flies constantly lived among and fed on wild game, such as buffalo and antelope, these animals were suspected. Their blood was examined, and before long it became evident that the wild animals acted as the reservoir of the disease, the trypanosomes living in their blood as harmless parasites. When the tsetse-fly fed on blood containing the trypanosome it became infected, and was capable by its bite of giving rise to a fatal disease in cattle, horses, or dogs; whereas if it fed on a wild animal nothing happened, as the wild game are immune to the disease, much in the same way as the goat is immune to Malta fever.

Now that the natural history of the disease had been so far worked out it was evident that its prevention might be attempted. This can be done in any of three ways: by getting rid of the wild game, the reservoir; or by getting rid of the fly, the vector or carrier; or, lastly, by removing the cattle, horses, and dogs to a safe distance from the "fly country." This work on nagana led later, in 1903, to the discovery of the cause and mode of prevention of sleeping sickness.

Sleeping Sickness.

About the beginning of the century an epidemic of this disease raged round the shores of Lake Victoria in Central Africa. It had been introduced into Uganda from the West Coast, where it had been known for many years as a curious and unaccountable disease. It was observed that although the disease spread in a West African village from man to man apparently by contact, no such thing occurred among natives exiled from their homes. The disease never spread if introduced into native compounds in the West Indies or America, however closely the slaves might be herded together. The disease remained shrouded in mystery, and nothing had been done in the way of prevention, until the matter was taken up by the Royal Society of London in 1902 and a Commission sent out to investigate. It is not necessary to go into details; suffice it to say that after one or two false starts the Commission in 1903 came to the conclusion that the disease was caused, as in nagana, by a species of trypanosome.

The question of the distribution of sleeping sickness in Uganda was then taken up. This disclosed the remarkable fact that the disease was restricted to the numerous islands in the northern part of the lake and to a narrow belt of country skirting the shores of t lake. In no part of Uganda were cases found mo than a few miles from the lake shore. The ne important step in the working out of the etiology w made when it was shown that the distribution of t disease was identical with the distribution of t common tsetse-fly of the country, *Glossina palpal* Where there was no fly there was no sleeping sickne

The problem was now solved. The epidemic cou be stopped either by getting rid of the fly or by r moving the natives out of the fly area. As the destru tion of the fly was impracticable under the circur stances, the second method was decided on. T natives were moved from the islands and lake sho and placed on healthy inland sites, and the epidem which had cost the Protectorate some 200,000 liv speedily came to an end.

This method of preventing disease, by removing m out of the zone of danger, is an extravagant one, a can only be done in exceptional circumstances. Uganda the native population could be easily move but it meant that from about 1910 until the prese day some of the most fertile land in Uganda has be lying derelict, has returned to the primitive jung The War delayed things, of course, but it is only n that the natives are being returned to their old hom on the islands and lake shore, in the hope that the by this time has lost its infectivity.

The other method, by the destruction of the tsets fly, has been carried out successfully in other plac For example, in the island of Principe, off the We Coast of Africa, by destroying the wild animals whi supplied a large part of the food of the fly and clearing the jungle, the tsetse-flies disappeared, and wi them the disease. This is the method employed malaria and yellow fever. It was by destroying t mosquito carrier that Gorgas drove yellow fever o of Havana and, later, both malaria and yellow fev from the Panama Canal zone. Thus through the wo of Manson, Laveran, Ross, Reed, and others has been made possible to deal with these two scourges the tropics, malaria and yellow fever. I include yell fever among the protozoal diseases, although Noguc in 1919 brought forward strong evidence that it caused by a spirochæte.

In regard to yellow fever the victory has been almo won. During the last century this disease, known "yellow jack," devastated the West Indies and Centr and South America. At the present time, thani chiefly to the unremitting efforts of the late Gener Gorgas and the International Health Board of t Rockefeller Foundation, the disease has been driven o of the West Indies and Central America, and on retains a precarious foothold in Colombia and Braz whence it will doubtless be ejected during the ne year or two.

One of the best examples of the prevention of disease the attack made on yellow fever in Rio de Janeiro, capital of Brazil, by the well-known man of science, Oswaldo Cruz, with the result that the annual ths in the city from yellow fever fell from 984 in 2 to 0 in 1909. This brilliant result was brought ut by the destruction of the Stegomyia mosquito, intermediate insect host in yellow fever.

So also in the case of malaria. A dozen years ago, sed on the experience gained by Ross on the West ast of Africa and Ismailia and by Watson in the derated Malay States, the method of prevention by squito control and drainage has been so perfected t the practical blotting out of malaria from a given ality is now merely a matter of expense. A great al of work has been done during the last few years the way of experiment in the United States, and ncent, the President of the Rockefeller Foundation, ely stated that there is evidence that "under normal nditions an average community can practically rid elf of malaria at a *per capita* cost of from 45 cents to per year."

This is an altogether inadequate account of the thods of preventing these highly important protozoal seases. From the few examples given it will be seen at they are most rampant in warm climates, that they e as a rule conveyed from the sick to the healthy by insect intermediary, and that it is by an attack on is insect, be it mosquito, tsetse-fly, or tick, that the st chance of success in prevention lies.

Infectious Diseases—(C) Undetermined Group.

In addition to the bacterial and protozoal infectious seases, there is a third and large class, known as the undetermined group," in which the parasite is either known or doubtful. Many of these undetermined iseases are very common and familiar, such as influenza, measles, scarlet fever, smallpox, typhus fever, rench fever, dengue fever, and sand-fly fever; among nimals, rabies, rinderpest, foot-and-mouth disease, and frican horse-sickness. The theory generally held at resent in regard to most diseases included in this roup is that the living germs causing them are ultramicroscopical, in at least some part of their life history, nd this is strengthened by the fact that many of them lass through porcelain filters, which keep back the mallest of the visible bacteria. Hence the name filter-passers."

Many of these undetermined diseases are highly infectious and appear to infect at a distance through the air, as, for example, in influenza, scarlet fever, and smallpox. In some of them there is no attempt made at prevention, except that the sick are isolated and placed under quarantine for a longer or shorter period. But in others there are well-known methods of prevention even when the virus is quite unknown. The best example is smallpox, the ravages of which have been completely held in check since the memorable discovery of Jenner. As has already been argued, this method of prevention, by inducing a mild or attenuated form of the disease, is at best a clumsy one, and when the natural history of the smallpox virus is better known it may be hoped that a more fundamental method of preventing this disease may be discovered. In the meantime the best means at our disposal is by the use of vaccine lymph, and people should recognise their responsibility to the community if through ignorance or selfishness they refuse to have their children vaccinated.

Another well-known disease with an unknown virus, rabies or hydrophobia, has also, by the genius and intuition of Pasteur, been robbed of many of its terrors. The mortality following bites of rabid animals has fallen from 16 per cent. to less than 1 per cent. But in rabies, when the conditions are favourable, the radical method is to drive the disease altogether out of the country by the careful administration of muzzling and quarantine laws. This was carried out successfully in England at the beginning of the century.

Trench Fever.

There are among the diseases of undetermined origin a few which are slowly emerging from the unknown into the known. One of the most interesting of these is trench fever, which came into great prominence during the War. The history of the investigation of this fever is interesting, and well illustrates the method of studying a disease with a view to its prevention. Before the War trench fever was unknown, though there is some evidence that it had been recognised at an earlier date in Poland and called Wolhynia fever. Be that as it may, it is quite certain that, though it was unknown on the Western Front at the beginning of the War, it is no exaggeration to say that it became one of the most powerful factors in reducing our man-power, probably more than a million cases occurring among the Allies on the Western Front. In 1917 in the Second British Army alone, out of a total of 106,000 admissions to hospital at least 20,000 of the cases were trench fever.

Although this fever has well-marked characteristics of its own, such as a peculiar type of temperature curve, and other symptoms, yet for a long time it was unrecognised as a separate entity, and remained mixed up with other diseases, such as typhoid fever, malaria, and rheumatism. In 1916 MacNee, Renshaw, and Brunt in France made the first definite advance by showing that the blood of trench-fever cases was infective. They succeeded in transferring the disease to healthy men by the injection of the blood. The most careful microscopic examination of the blood corpuscles and lymph failed, however, to reveal any

living germ. Nothing more was done until the following year, when the British War Office took the matter up seriously and formed a committee for the purpose of investigating the disease.

The United States of America, on coming into the War, at once recognised the importance of trench fever, and without delay also undertook its investigation. In October 1917, at the first meeting of the Medical Research Committee of the American Red Cross in Paris, Major R. P. Strong recommended that a research into trench fever should be undertaken. He stated that, after several months' study of the problems relating to the prevention of infectious diseases occurring in the Allied Armies on the Western Front, it became evident that the subject of the method of transmission of trench fever was one of the most important for investigation in connexion with the loss of man-power in the fighting forces.

At the next meeting, in November 1917, this was agreed to, and a Trench Fever Committee, under the chairmanship of Major Strong, was formed. The research was organised, and experiments begun on February 4, 1918. In less than six months the investigation was completed and the report in the hands of the printer. This is a striking example of research work which, if carried out at the beginning of the War instead of at the end, might have saved the Allied Armies hundreds of thousands of cases of disease, which, although never fatal, were often of long duration and led to much invaliding.

The most important result of the work of these two committees was that it was amply proved that the louse, and the louse alone, was responsible for the spreading of the disease. This discovery meant that in a short time trench fever would have disappeared from our armies on the Western Front. Just as the elimination of goat's milk blotted out Malta fever, the elimination of the mosquito malaria and yellow fever, so would the elimination of the louse have completely blotted out trench fever. This method of prevention, by the destruction of the louse, although doubtless requiring careful organisation and energy in carrying out, was shown before the end of the War to be a perfectly practicable proposition, and there can be little doubt that, if the War had lasted much longer, trench fever, like tetanus, would have practically disappeared.

Besides the main discovery from the preventive point of view that the louse is the carrier, there are many other points of interest in the natural history of trench fever. The living germ causing it has never been recognised in the human blood or tissues, probably on account of its extreme minuteness, and its consequent liability to confusion with other small granules. But when the louse sucks blood from a trench-fever case there is apparently a great multiplication and development of the supposed micro-organism. In five to nine days the louse becomes infective, and there is seen in the stomach and intestines enormous numbers of very minute bodies. What the exact nature of these bodies is, is unknown, but there can be little doubt that they are the infecting agents by which the louse passes on the disease. They pass out in countless numbers in the droppings or excreta of the louse, and it is to these bodies in the excreta that infection is due. The louse seldom if ever gives rise to the disease in the act of biting. It is the infective excreta thrown out on the skin which causes the infection. The micro-organisms or so-called Rickettsia bodies contained in the excreta find their way into the blood through abrasions or scratches, and so give rise to the fever.

From what has been said it will be seen that trench fever is an interesting disease. It also explains why it disappears in times of peace. As soon as the War was ended, and our men could leave the trenches and resume their normal habits, the disease disappeared. The louse was eliminated and the trench fever with it.

Typhus Fever.

Another disease of the undetermined group closely related to trench fever and also carried by the louse is typhus fever, one more of the furies following on the heels of war. The French and British Armies escaped this scourge to a great extent, but some of the other countries, such as Serbia, Bulgaria, and Poland, were not so fortunate. It is stated that 120,000 Serbians died of this disease during the War, and it was only after vigorous steps had been taken in sanitary measures directed against the louse that the epidemic was got in hand.

After the long, exhausting Napoleonic wars, with the resulting poverty and destitution, typhus fever was prevalent in Great Britain and Ireland. About the middle of the century the improved economic conditions gradually led to the disappearance of the disease in Britain, although cases still occur in some parts of Ireland.

It is to Nicolle that we owe the advancement in our knowledge of this important disease. His work in Tunis on this subject dates from 1909. He showed that the blood of typhus cases is infective to monkeys, and, most important of all, that the infection takes place through the body louse. Just as in trench fever, the louse becomes infective after some five days, and it has been shown by the late Arthur Bacot of the Lister Institute that the excreta is also infective.

The minute bodies found in the typhus louse are, subject to some differences, very similar to those found in the trench-fever louse, and have been named *Rickettsia prowazeki* by Rocha Lima. What group these bodies belong to is still a matter of discussion. Some consider them to be protozoa, with an ultra-

roscopical stage in man and a developmental stage the louse, while others look on them as minute ms of bacteria. Although there is still some doubt o the pathological significance of these Rickettsia ies, the work of Sargent, Rocha Lima, Arkwright Bacot, Wolbach, Todd and Palfrey has done much establish a causal relationship between them and se two diseases, typhus and trench fever.

From the point of view of prevention, the important at is that the infection is carried by the louse, and in next great war it will be almost as necessary to pare means for the destruction of the lice as of the my.

Rocky Mountain Fever.

A third disease belonging to this interesting little up—Rocky Mountain fever—occurs in certain alities in the United States. It provides another stance of a virus transmitted by an invertebrate host man. As the result of the work of Ricketts and of olbach, the wood-tick, *Dermocentor venustus*, is now cognised as the vector. Rickettsia bodies closely sembling those found in association with typhus and nch-fever virus have been shown to be present in stomach and tissues of the tick, and the same dies have also been demonstrated in the tissues of fected guinea-pigs.

Another interesting disease of the undetermined oup is sand-fly fever, the virus of which is conveyed om man to man by the sand-fly. A new era in its dy has been opened up by the work of Whittingham d Rook, who have learned how to handle, breed, d keep sand-flies in captivity, and have shown that e virus is transmitted from generation to generation flies without intervening passage through man or her higher animal. The knowledge of the life history the flies will no doubt lead in due course to the ppression of the disease.

Another type of invertebrate vector is the Kedani ite, *Trombicula akamushi*, which transmits the virus Japanese river-fever to man from wild animals. e dangerous character of this disease (Tsutsugamushi) d the minute size of the mite together have pre- nted great difficulties to the Japanese investigators. rotection from the mite by special clothing and thing after exposure to risk of infection are at esent the most hopeful methods of prophylaxis.

Antitoxic sera have also been used with some easure of success in the prevention of diseases of this oup. Degkwitz and others in Germany are reported have been very successful in protecting children om measles and scarlet fever by injecting them with small quantity of serum from convalescent patients. his method has also been found very useful under itable conditions to protect cattle from foot-and- outh disease.

But far more hopeful than protection by serum alone is the use of a vaccine to produce a lasting immunity, combined with antitoxin to prevent the vaccine from producing unpleasant results—the so-called toxin-antitoxin method. Most of the diseases for which this method of prophylaxis has proved valuable have been diseases of animals, such as pleuro-pneumonia of cattle, rinderpest, and foot-and-mouth disease; but quite recently the method of Dick, of Chicago, in scarlet fever has been supported by a number of observations. The system of testing and producing immunity is planned on the same lines as the Schick method for diphtheria.

Dietetic Deficiencies—Deficiency Diseases.

The preceding account is but a short and meagre history of the marvellous advance which has been made in the prevention of infectious diseases in our times, an advance due in great part to the work of two men, Pasteur the Frenchman and Koch the German; those who have come after them have merely followed in their footsteps, been their disciples.

Time will not permit even to touch upon the advances made in the prevention of other important diseases, such as the surgical infections and those caused by intestinal parasites, prominent among which are the hookworms and bilharzia. This advance has not been limited to the infectious group: it has been shared by other groups, notably those due to dietetic deficiencies, the so-called deficiency diseases. These deficiency diseases are just as important, or even more important, than the infectious, since they are always with us and exact an enormous toll in lowered health, lowered vitality, malformation, and inefficiency.

Until a few years ago it was taught in the schools that a complete diet consisted of certain proportions of proteins, carbohydrates, fats, and salts. But our knowledge is constantly increasing, our ideas about things constantly changing, and what is looked on to-day as absolute immutable truth to-morrow is seen in the light of some newer knowledge to be but a crude beginning. So the teaching concerning what constitutes a complete and healthy diet has changed, inasmuch as certain substances have been discovered in food-stuffs in the absence of which an adequate number of calories supplied in the form of proteins, carbohydrates, fats, and salts can alone neither promote growth nor support life indefinitely. These accessory food factors, or vitamins as they have been named, are present in such minute quantities in foods that they have never been isolated, and their chemical composition is therefore unknown. It is still a matter of opinion as to whether they really constitute parts of the structure of living tissues, or whether they merely act as catalysts or stimulators in the process of growth and metabolism. That they are definite chemical

substances which can be added to or removed from a food-stuff, with good or evil results, has, however, been abundantly proved.

The untutored savage living on the natural fruits of the earth and the chase knows no deficiency diseases. It is only when man begins by artificial means to polish his rice, whiten his flour, and tin his beef and vegetables that the trouble begins. Civilised man living in comfort, drawing his food supply from the whole earth and able to vary his dietary at will, is in little danger; but it is otherwise with children and adults living under institutional conditions, with armies on active service, encountering extremes of climate, and with young infants on their naturally restricted diet. While it is true that deficiency diseases will only develop to their well-marked dangerous stage if the deficiency of accessory factor is severe and protracted, a slighter deficiency, if prolonged, may cause a condition of general ill-health and inefficiency not less important although ill defined and difficult to diagnose. This fact is of special importance in the case of infants and young children.

The Discovery of Vitamins.

At the present time, three, and possibly four, distinct vitamins have been described and studied, and it is probably only a matter of time for others to be discovered.

The discovery of vitamins dates to the middle of the eighteenth century. In 1747, James Lind, a surgeon in the British Navy, carried out a series of experimental observations upon sailors suffering from scurvy, the conception and performance of which were entirely admirable. By appropriate control experiments he showed that the medical means in vogue for the treatment of the disease were futile, when not harmful, but that orange and lemon juices were a specific cure. Lind attempted to ascertain the relative anti-scorbutic value of various fruits and green vegetables, but was unable to observe a "superior virtue" in one rather than in another. He confirmed Kramer's observations made at the beginning of the eighteenth century, during the war between the Turks and the Holy Roman Empire, that dried vegetables were useless, and adopts the explanation of his friend Cockburn "that no moisture whatever could restore the natural juices of the plant lost by evaporation," which Cockburn imagined were "altered by a fermentation which they underwent in drying."

Lind was struck with the beneficial effect of cow's milk in the treatment of scurvy. He explained it on the supposition of the milk "being a truly vegetable liquor, an emulsion prepared of the most succulent wholesome herbs." Lind applied himself to the applications of these discoveries for the prevention of scurvy in the Navy, and recommended lemon-juice concentrated to a syrup by evaporation to be carried in all ships and served out to the sailors. By the beginning of th nineteenth century the carriage of lemon-juice was mad compulsory, first in the Navy and subsequently in th mercantile marine, with the result that the ravages o scurvy were prevented. With the advent of steam traction, too, the length of voyages was curtailed an supplies of fresh provisions were obtained at mor frequent intervals. Scurvy became rare, and th medical profession, being no longer faced with th disease of dietary deficiency, soon forgot the significanc of Lind's discoveries.

Before leaving this subject a curious fact may b related. The lemon-juice supplied to the Navy was a first made from lemons grown in Spain and the Mediter ranean countries. Afterwards, when England took ove the West Indies, it was made from the lime, and scurv again broke out. The reason of this is now known t be that, whereas the lemon is particularly rich in anti scorbutic vitamin, the lime is correspondingly poor.

The scientific study of the disease may be said to hav lapsed for a century and a half, until Holst and h co-workers in Copenhagen investigated the etiology o scurvy anew on modern lines, with the help of experi ments on animals. Their work, published in 1907 an 1912, formed the basis for the numerous researche carried out in England and America during and sinc the recent War. As a result of this work the etiolog of scurvy, discovered in effect centuries earlier, has bee firmly established as due to lack of a specific, undeter mined, and as yet unisolated, constituent of fresh foods especially of fresh vegetables and fruits, now known a Vitamin C.

In the meantime the existence of a second vitamin the so-called anti-beri-beri, or anti-neuritic vitamin Vitamin B, had been discovered. Eijkman's admirabl studies at the end of last century, in 1897, on th etiology of beri-beri in the Dutch Indies, brough forward evidence for the view that this disease was o dietetic origin, and was caused by a diet consisting to exclusively of highly milled and polished rice. H showed that the disease could be prevented if the outer layer (or pericarp) and the embryo of the seed, which had been removed in the process of milling, were restored to the "polished" rice. Eijkman's discovery of the analogous disease in birds, *Polyneuritis gallinarum* provided the necessary tool for further investigation o the subject. The researches of Grijns and others showed that the bran and polishings of rice were only one of many rich natural sources of the unknown principle preventing beri-beri, and it became evident that, while the disease is usually confined to tropical races subsisting largely on rice, the European white bread eater is protected only by the varied diet h usually enjoys. Experience on active service show that beri-beri may really develop on a diet of tinned meat and white bread or biscuit.

During the late War two examples of the use made of t s new knowledge occurred in Mesopotamia. At the ginning of the campaign, on account of a difficulty in nsport, there was a shortage of fresh food, with the rious result that scurvy broke out among the Indian ops and beri-beri among the British. The Indians re living on dried pulses, such as peas, beans, and tils; the British on tinned beef and biscuits. The mer diet was deficient in the anti-scorbutic vitamin account of the complete drying of the seeds; the ter in the anti-beri-beri factor on account of the use white flour from which the germ had been removed.

Some years ago it had been discovered that if dried eds are germinated, a quantity of the anti-scorbutic tamin is produced by the act of sprouting. This was ne. The dried peas and beans were soaked in water d then spread out in shallow layers, to cause them to rout, which they readily did in the warm climate. he germinated seeds were then issued to the Indian ops and cooked in the usual way. As a result of this mple procedure the scurvy completely disappeared.

In regard to the British troops it was known that the nti-beri-beri vitamin is contained in large quantities certain cells, and notably in yeast cells. A small antity of this substance in the form of marmite was ded to the soldier's diet of bully-beef and biscuits, d the beri-beri in like manner disappeared.

It may seem strange that the conception of the rôle vitamins in nutrition should have come first from the thologist, and should not have emerged from the portant advances in our knowledge of the physiology nutrition which were made during the second half of he last century. The physiologists were preoccupied ith the chemical composition of food-stuffs and their lue for supplying energy and supporting growth, and ith the necessity for supplying the requisite number of lories in a diet, distributed appropriately among roteins, fats, and carbohydrates, with adequate lection of mineral salts. It was only when these searches led to experiments in which animals were fed pon various mixtures of purified food elements that he investigators in this field began to realise that their peated failures to rear animals upon such carefully rranged diets were not due to accident. The truth as suspected by Lunin in 1881, but it was not until 912 that Hopkins published the classic experiments hich proved the fact beyond a doubt. In the course f work along the same lines in the United States, IcCollum and Davis in 1915 rediscovered Vitamin B, nd, in addition, a third essential dietary constituent, a at-soluble vitamin, present in butter-fat and certain ther fats of animal origin, especially in cod-liver oil nd other fish oils. This vitamin is known as fat-oluble Vitamin A.

Rickets as a Deficiency Disease.

The discovery of the fat-soluble vitamins proved to be of great importance in elucidating the etiology of this disease, which had for long been an unsolved problem. Some authorities had erroneously considered it to be an infectious disease, like tuberculosis. Another school held the so-called Domestication Theory, that it was caused by unnatural surroundings, involving a want of sunlight, fresh air, and exercise. A third considered rickets to be caused by improper feeding, though opinions differed as to the exact nature of the dietetic defect. The conclusion, first put forward by Mellanby in 1918, that a deficiency of fat-soluble vitamins plays a most important part in the causation of the disease is now generally accepted. This has been established by a large amount of work, both experimental and clinical, carried out by Mellanby himself, McCollum and Hess and their respective co-workers in the United States, and Korenchevsky and others in England. It may be laid down that if a young animal is supplied with a sufficiency of these vitamins, rickets will not develop. The question of prevention is therefore one of economics. The difficulty is that these fat-soluble vitamins are chiefly found in such food-stuffs as butter, eggs, the fat of beef and mutton, and fish oils, all expensive articles of diet which the poorer classes can seldom afford. The only "butter" used by them is probably some form of margarine, made from vegetable oils which contain little or no anti-rachitic vitamin. The question of prevention is for the sociologist. Science can only discover the causes and point the means. It is for governments and local authorities to carry out preventive measures in practice, and it is to be feared that science is often far ahead of the community in its share of the work.

Although the theory that rickets is an infectious disease has been exploded, a great and remarkable truth was contained in the domestication and hygienic theories which held that, among other unhygienic conditions, want of sunlight was concerned in the etiology of the disease. During the last five years it has been discovered that exposure to sunlight or to the ultra-violet rays of the mercury vapour quartz lamp can cure rickets in children. Experiments on animals have shown that the effective rays in the sunlight are also the ultra-violet. This discovery has indicated lack of sunlight during winter as one factor concerned in the large spring incidence of the disease in industrial cities in northern climates.

A complete and well-controlled research showing the interaction of diet and light in the prevention and cure of rickets in infants was gained in Vienna, since the War, by Dr. Harriette Chick of the Lister Institute and her four colleagues. There the curious fact came to light that infants fed on a diet deficient in anti-rachitic vitamin developed the disease only in winter and not in summer, and, moreover, could be cured in winter by exposure to artificial forms of radiation or by administration of cod-liver oil without any other change in diet or management. Another set of children who had a sufficient supply of fat-soluble vitamins in their diet, in the form of cod-liver oil, escaped the disease altogether.

Experiments on rats have also shown that in animals fed on a rickets-producing diet, rickets does not occur if the rats are exposed regularly to sunlight or to the rays of the mercury lamp, or other form of artificial ultra-violet radiation; whereas, if they are kept in the dark, rickets does develop. If, on the other hand, the diet is complete in all respects, including abundance of fat-soluble vitamins, the animals do not develop the disease, even if kept constantly in the dark.

How this is brought about is not known. At one time it was thought that the action of the ultra-violet rays on the tissues might enable the animal to syn-

thesise fat-soluble vitamins, as it does in the tissues of plants, but recent evidence brought forward by Miss Margaret Hume in Vienna, and by Goldblatt and Soames at the Lister Institute, suggests that light can neither create nor act as a substitute for the vitamin. It seems rather to act as a stimulant, enabling the animal to make full and economical use of its store of fat-soluble vitamins, and when the store is used up growth ceases in spite of the continued action of the rays.

An important and practical point in regard to the connexion between diet and sunlight and the formation of the anti-rachitic vitamin is the relation to cow's milk. Recent work carried out by Dr. Ethel Luce at the Lister Institute has shown that milk obtained from a cow on pasture in summer contains a sufficiency of the growth-promoting and anti-rachitic fat-soluble vitamins. In winter, on the other hand, if the cow is stall-fed and kept in a dark stable, the milk may become deficient in these respects and young animals fed on it may become rachitic. This work shows that the seasonal variation in quality of the cow's milk may be an additional factor in the seasonal incidence of infants reared upon it. It also disposes of the idea, very current in some quarters, that cow's milk possesses low and negligible anti-rachitic properties and that the anti-rachitic properties of cod-liver oil are specific and peculiar to that substance.

Enough has been said to show that rickets may be regarded as a disease of sunless houses combined with a diet deficient in the anti-rachitic vitamin, and the means of prevention are sufficiently obvious, if not always easy and simple to carry out. Doubtless in the future this new knowledge in regard to the accessory food factors in diet will be used to a greater extent than it has been up to the present, in which case it is not too much to expect that the city children of some future generation will have better-grown bodies and stronger, healthier teeth than their predecessors of the pre-vitamin age. This might be attained in a comparatively near future if only man could be allowed to work out his salvation in peace. Instead of this, great wars come and throw back the work for generations.

To saddle the country with a million and a half of unemployed, with the consequent poverty, insufficient food, clothing and housing, is not calculated to further the prevention of disease and raise the standard of health. Is it too much to hope that in the revolving years a time may come when by a Confederation or League of Nations the world may be so policed that no one country will be able with impunity to attempt the destruction of its neighbour? Until this happens it is difficult to see how rickets, tuberculosis, and other diseases can be adequately dealt with in our city populations.

Diseases due to Ductless Glands

I can only briefly allude to the astonishing advance in our knowledge of the diseases caused by a defect or excess of secretion of the ductless glands. Many of these discoveries are among the fairy tales of science. All this advance has taken place in the comparatively short space of time under review.

Prof. Starling, one of the chief protagonists in this advance, in his Harveian Oration a year ago states this very vividly: "When I compare our present knowledge of the workings of the body, and our powe of interfering with and of controlling those workin for the benefit of humanity, with the ignorance an despairing impotence of my student days, I feel tha I have had the good fortune to see the sun rise on darkened world, and that the life of my contemporarie has coincided not with a renaissance but with a ne birth of man's powers over his environment and h destinies, unparalleled in the whole history of mankin Not but there is still much to be learned: the ocean the unknown still stretches far and wide in front of u but for its exploration we have the light of day to guid us; we know the directions in which we would sai and every day, by the co-operation of all branches science, our means of conveyance are becoming mo swift and sure. Only labour is required to exten almost without limit our understanding of the huma body and our control of its fate."

There is one point of likeness between the vitamin which we have been considering and these glandula secretions, or hormones, as they are named. Just a we have seen that the presence or absence of a extremely minute quantity of a vitamin may determin growth and health or disease and death, so an extremel minute quantity of glandular secretion may have similar effect.

The anterior lobe of the pituitary gland is a ver small body, yet an excess of its secretion will cause child to grow into a giant; a deficiency, and the grow ing child will remain an infant.

The best known of the ductless glands is the thyroid and the effect of its secretion is truly marvellous. deficiency, and the child grows up a heavy-featured gibbering idiot. Rectify the supply of thyroid secre tion; the heavy features disappear, the eyes brighten the intelligence returns, and instead of the forme heavy-jowled imbecile you have a bright, happy, an normal schoolboy. On the other hand, if there is a excess of the thyroid hormone, exophthalmic goitre, o Graves's disease, is the result. Remove the re dundancy and health returns.

The active principle of the thyroid has lately bee shown to be a compound containing iodine. If ther is no iodine in the soil or water, goitre is the result, a in parts of Switzerland, Canada, and the United States This aspect of the subject was taken up some ten year ago by Dr. David Marine and his colleagues at Cleve land, Ohio. They find that endemic goitre may b prevented by the simple method of giving for a tim minute doses of iodine, and conclude that with thi simple, rational, and cheap means of prevention, thi human scourge, which has taken its toll in misery suffering, and death throughout all ages, can and should be controlled, if not eliminated, and look forward i imagination, a few generations hence, to the fina closing of the chapter on endemic goitre and cretinism in every civilised nation in the world.

Many advances have also been made in our know ledge of the function and uses of other ductless glands and, as you know, the latest victory in this field is the discovery of insulin and the successful treatment o severe diabetes, for which magnificent work your own townsmen Banting and Best deserve the highest honour.

In many other directions than those touched upon has there been progress in the prevention of disease

would take more than one address to describe the ivities of the Rockefeller Foundation alone. Cam-gns for the relief and control of hookworm disease, laria control, the eradication of yellow fever, anti-erculosis work and education are being pursued on h a scale and at such a lavish expenditure of money to leave us in the Old Country breathless with miration and envy.

This Foundation, incorporated in 1913, was founded, the words of the president, "to stimulate world-wide earch, to aid the diffusion of knowledge, to encourage operation in medical education and public health." chartered purpose is to promote, not the exclusive sperity of any one nation, but "the well-being of nkind throughout the world."

Science, indeed, knows no boundaries of nations, nguages, or creeds. It is truly international. We all children of one Father. The advance of know-lge in the causation and prevention of disease is not the benefit of any one country, but for all—for the lely African native, deserted by his tribe, dying of eping sickness in the jungle, or the Indian or Chinese coolie dying miserably of beri-beri, just as much as for the citizens of our own towns.

From what has been said, it is abundantly clear that during the comparatively few years that have passed since this Association first met in Canada, enormous advances have been made in the prevention of disease. Before that time we were still in the gloom and shadow of the Dark Ages. Now we have come out into the light. Man has come into his heritage and seems now to possess some particle of the universal creative force in virtue of which he can wrest from Nature the secrets so jealously guarded by her and bend them to his own desire.

But let there be no mistake; much has been done but much more remains to be done. Mankind is still groaning and travailing under a grievous burden and weight of pain, sickness, and disease. Interruptions are sure to come in the future as they have in the past in the work of removing the incubus, but, in spite of these, it is the duty of science to go steadily forward, illuminating the dark places in hope of happier times.

Scientific Problems and Progress.

Abstracts of Addresses of Presidents of Sections of the British Association.

Chemistry and the State.

In Section B (Chemistry) Sir Robert Robertson took "Chemistry and the State" as the subject of his residential address. The relations of the State to hemistry in Britain originated in the necessity for self-rotection; they developed from motives of expediency; nd they have culminated in direct Government aid for search. From the time when gunpowder was first made r the State in the fourteenth century down to the pro-uction of amatol during the late War, the State has ways interested itself in the manufacture of explosives, ut important scientific research in this connexion began nder Abel and his co-workers, Kellner, Deering, ewar, and Dupré, who developed the use of guncotton nd cordite. Outstanding advances in the manufac-ure of explosives emanated from the Royal Gunpowder actory, and general research was carried out both here and in the Research Department, Woolwich. The War caused an enormous expansion of the State's ctivities in the production and investigation of hemical means of defence and offence.

The relations of the State to metallurgy were mostly poradic before 1914, the main advances arising from rivate effort, but Percy, Abel, and Roberts-Austen, ll of whom held official posts, assisted the Government n many inquiries, and more recently notable work on he non-ferrous alloys has been done at the National hysical Laboratory, ferrous metallurgy being studied n the Research Department, Woolwich. The State has always maintained a close connexion with minting, nd many of the Mint officials, including Hofmann, Graham, Miller, Stenhouse, and Roberts-Austen, have made important additions to metallurgical science.

Expediency caused the State to levy duties on lcoholic liquors, tobacco, and other commodities. Richard I. imposed a duty on imported wine, and under Charles II. acts were passed to prevent the mixing and adulteration of wines (it is still illegal to mix wines of different kinds). Accurate methods of testing spirits, etc., have been elaborated in the Government Laboratory, and much work has been done there on the denaturing of alcohol.

Playfair, supported by the Prince Consort, pioneered the direct intervention of the State in sanitation and control of the quality of foodstuffs; investigations on the adulteration of foods and drugs followed and led to the appointment of public analysts, to the extension of the work of the Government Laboratory, to the establishment of the Ministry of Health, and to the formulation of certain definitions and standards for spirits, dairy products, preserving and colouring matters in foods, etc. The State has also promoted or done very valuable work on the purity of water supplies, the disposal of sewage, the contamination of the atmosphere, and has established chemical control of many manufactures dangerous to health.

Although Humphry Davy was a member of the first Board of Agriculture, formed in 1793, progress in agricultural chemistry was left to private enterprise for more than a century; the establishment of the Development Commission in 1909 paved the way to important advances which have originated at Rothamsted and other State-supported institutions. The shortage of fixed nitrogen and of potash during the War made Government action imperative; and the valuable work of the Nitrogen Products Committee has been followed up by the establishment of a nitrogen industry at Billingham-on-Tees, where 150 tons of synthetic ammonia are now being produced daily.

The greatest advances in chemistry have been made in the universities and by private workers, but the contributions from Government institutions have not been unimportant; and the benefit has been mutual. During the War the State recognised its obligation to

foster research, both in pure and applied science. Under the schemes of the Department of Scientific and Industrial Research the smaller chemical manufacturers are co-operating in the investigation of common problems, and the assistance extended by that department to academic workers shows that the State recognises the truth of the dictum that "research in applied science may lead to reforms, but research in pure science leads to revolutions."

Geology in the Service of Man.

Prof. W. W. Watts, president of Section C (Geology), selected "Geology in the Service of Man" as the subject of his presidential address. He pointed out that the mining industry, by providing exposures of rocks in mines, and by demanding as it did accurate knowledge of the nature and structure of the earth's crust, had been an important factor in the growth of the science of geology. He paid a tribute to the early work of Werner and William Smith from this point of view. It is a curious fact that these two pioneers of the science of geology were strongly imbued with a sense of the utility of geological science, and made their contributions to the establishment of the science with an economic motive. During the nineteenth century the purist attitude of mind became dominant among geologists, and it can scarcely be said to have faded out as yet; but, as Prof. Watts remarked, the feeling of mutual suspicion and distrust between the purely scientific and economic workers is fortunately passing away. The scientific and economic workers now find that they are mutually indispensable, and are everywhere co-operating in the work of developing and exploiting the mineral wealth of the earth's crust.

With reference to the study of geology as a factor in educational training, Prof. Watts deplored "the tendency in early education to squeeze out other sciences in favour of those that are called fundamental, and to suppose that, because it makes use of most other sciences, training in geology ought not to be begun until the other sciences have been mastered." He pointed out that, in consequence of this tendency, the habit of close observation is not being cultivated as it should be. The student's early propensity for making observations is blunted unless it be encouraged by studies such as those of practical geology, the pursuit of which has the additional advantage that it gives the student a stronger incentive to the study of the fundamental sciences and shows him their utility.

Under the sub-headings coal, oil, metals etc., stone etc., roads, water, power, agriculture and forestry, military science, geography, and biology, Prof. Watts showed in an interesting way how very wide, permeating, and altogether important are the influences of the science of geology in the service of man. The address will be read with much interest by all who appreciate the economic value of science in general and geology in particular.

Racial Problems and Colonisation.

As president of Section E (Geography), Prof. J. W. Gregory, in his address on "Inter-Racial Problems and White Colonisation in the Tropics," appropriate directed attention to the immense problems of popul tion arising from the unification of the modern world the movements and organisation of commerce. Peopl of very diverse heredity are brought into mass conta and the results are difficult to evaluate, especially prejudices of many and often conflicting types enter in the discussion. Prof. Gregory quotes views on mar points, and scarcely attempts to give an opinion racial fusions; he indicates South America as a regi where such fusion has occurred and is still developi on a large scale, and the United States of America a region where the strongest opposition to such fusion h been offered by both sides. He evidently thinks th the maintenance of black and white side by side b distinct in the U.S.A. is an impossibility, especially view of the increase of southern European elements the population of late years. In that opinion he wi the agreement of a great many thinkers and worker Prof. Gregory, however, scarcely gives attention modern demographic work in the U.S.A., such as th of W. F. Willcox, who claims that in every one of t Northern States negro deaths exceed negro births, an that this is probably true in cities generally. Moreov the negro, as Prof. Gregory shows, is tending to mov to the towns. Willcox and his fellow-workers do n expect the negro to maintain himself at 19 per cen of the population, but argue that in the year 2000 may be only 5 per cent. This, however, may pr suppose a rather large increase of whites, and may n take enough account of the influence of souther Europeans in producing "near whites." At any rat it seems clear that census errors in 1870 have sprea an erroneous idea about increase of negro populatio in U.S.A.

Prof. Gregory touches the South African problen where the "black" is at home and increasing, whi the white finds more difficulty in maintaining himse physically and economically than he seems to indicat He seems right in urging that the Nationalist Labou Coalition in South Africa is based on racial politic with the ideal of black segregation, in the hope th large areas may become homes of pure European The hope is dim enough. Prof. Gregory is enthusiast about the white Australia policy, and upholds strenu ously the view that disease, not climate, is the enem of white settlement in the tropics. From this point view he makes the most of the partial success of Nort Queensland, and discounts failures in the Norther Territory as due largely to lack of organisation, railway etc. At the same time he acknowledges that, whe wet-bulb temperatures are high, the environment against strenuous mental activity, though he does n go so far as does Dr. Leonard Hill towards suggestin that the white man would need to modify himself an his ways in order to occupy Northern Australia seriously Nor does Prof. Gregory mention the probability tha what may drift to Northern Australia may be a Pass-fo White population. He rightly points out that ther are immense spaces that the surplus population China may occupy in Asia, but he does not seriousl refer to the delicate and pressing problem of the crowde population of Japan. It is doubtful whether man Japanese constitutions could stand interior continenta climates in Asia at all. One cannot but welcome a

eresting statement of a position taken up by a much-velled geographer on the most urgent problem of time.

Free Trade Doctrine.

Sir William Ashley took as the subject of his sidential address to Section F (Economic Science d Statistics) "A Retrospect of Free Trade Doctrine." ere is a peculiar appropriateness in both speaker and ject. Sir William Ashley went to Toronto in 1888 occupy the first chair of political economy in Canada; has been throughout his career the chief academic tic of free trade in the English-speaking world. His dress has, however, only an incidental bearing on rrent controversies. The doctrine that he expounds d criticises is the doctrine formulated by Adam ith and his successors, in the century that began th the publication of "The Wealth of Nations" and ded with the new orientation given to economic dies by Jevons and Cliffe Leslie.

Sir William Ashley begins by formulating the ctrine for convenience of reference in nine pro-sitions. Each of these he then expounds with an undance of quotations from representative economists the period, and proceeds to criticise in the light of nomic developments during the period and since its se. In the main the address is an essay in the tory of economic thought, marked by the literary ace and the pleasantly acid wit that characterise r William Ashley's critical work; so far as it has an ject beyond this, it establishes the conclusion that e political doctrine of Smith and Cobden and Mill longs to the thought and conditions of an age that past.

It is the doctrine, not the policy, of free trade with hich the address is concerned, and this the president ows conclusively is based, not on an inductive argu-ent from experience, but on the optimistic philosophy r theology) of Nature that was common to "The heory of Moral Sentiments" and "The Wealth of ations." The identities of phrase in the two are everly used to bring out the a priori character of the tter. Nature is beneficent; it follows that the nrestricted freedom of the individual to pursue his wn interest can have only beneficent effects. Such reedom is a "natural" right; State interference is artificial." It follows that the individual interest nd the social interest are identical, and society is othing more than a collection of individuals. A ubsequent age, with a different philosophy, has had o difficulty in seeing that the use of "Nature" and natural" in these connexions is question-begging. he purely economic elements in the doctrine show ore definitely the influence of contemporary economic onditions; the criticism to which they are subjected s also different. They are tested by reference to conomic facts and conditions of their own and other imes, and their inadequacy brought out. Social olicies have changed as much as social philosophies.

The free trade doctrine was the creation of philo-ophers and the instrument of practical men. This ummary of its content and development brings out he changes that economics had to make in its objects nd methods before it could claim to be scientific. The address is typical of the work which Sir William Ashley has done to free the study from the bonds of mere analytical introspection.

Engineering Position and Prospects.

Prof. G. W. Howe, in his presidential address to the Engineering Section, gave a *résumé* of the advances made in engineering during the last hundred years. He regarded Faraday's discovery of the principle of the electro-motor in 1821 as the birth of electrical engineering. It was not, however, until ten years later that Faraday discovered magneto-electric induction. The early workers did not realise that a dynamo could be used either as a generator of electrical energy or as a motor. Lord Kelvin installed one of the earliest house-lighting installations at 11, The University, Glasgow, in 1881, using a gas engine to drive a Siemens dynamo. The pressure was 85 volts and Swan lamps were used, but Kelvin had to design his own switches and fuses and think out how to support and distribute his lamps.

Prof. Howe mentions that in Glasgow he pays 5*l.* per ton for anthracite to burn in a slow-combustion stove. Assuming that the calorific value of anthracite is 14,000 B.T.U. per lb., this works out at 7·5 kilowatt-hours for a penny. He pays a penny for a kilowatt-hour for heating and cooking. For continuous operation, therefore, the high efficiency and convenience of a slow-combustion stove makes it much the more desirable. When, however, intermittent heating is desired the electric radiator may be the more economical. An interesting account is given of how the output attainable from a given size of machine has been slowly but continuously increased. This is due to the improvements in the electrical, magnetic, and mechanical properties of the materials used as well as to improvements in design. Considering the modern direct current motor, the freedom from trouble of the enormous number of motors in electric trams and trains is a testimony to their trustworthiness.

Prior to 1890 Ferranti had built the Deptford Power Station and was installing large 10,000 volt alternators to supply London with electric light. In 1913 the largest turbo-alternators had an output of 7500 kilowatts. Now, machines of 30,000 kw. and even 60,000 kw. are in operation. Electric traction has absolutely revolutionised the methods of transport within a single generation. Although 500-volt direct current supply has been standardised for tramways, the relative merits of direct current and alternating current for traction purposes are still being discussed. Prof. Howe is inclined to regard three phase supply for traction, notwithstanding its successful application in Northern Italy, as being antiquated. The battle is now confined to direct current at pressures between 1500 and 2000 volts and single phase alternating current. In the latter case the question of the most desirable frequency is not yet settled. The development of the alternating current traction motor during the early years of this century has made possible so many simplifications and economies in transmission that it is yet a moot point whether A.C. or D.C. is best for main line electrification.

Within the last thirty years the provision of an

abundant supply of electric power has led to the creation of enormous electro-chemical industries. The production of aluminium, carborundum and calcium carbide by electrical energy obtained from waterfalls may be specially mentioned. In 1926 the jubilee of the invention of the telephone by Alexander Graham Bell will be celebrated. The great advances recently made in automatic telephone stations where the operator is entirely eliminated and the subscriber himself makes the required connexion are well described as marvellous. What were considered wild dreams, twenty years ago, of the future of radio-communication have been completely realised in everyday practice. The commonplace radio-broadcasting of to-day appeared outside the bounds of possibility a few years ago. Thirty years ago a ship at sea was completely isolated from the life and thought of the world. It is now in continuous communication with the land and with every ship within a range of many miles. Prof. Howe points out that in no branch of electrical engineering is there any question of finality being attained. Rapid development is taking place in every direction, and new natural sources of energy are continually being utilised for the benefit of humanity.

National Health and Physique.

In his presidential address to the Section of Anthropology, on "Health and Physique through the Centuries," Dr. F. C. Shrubsall reviews some of the evidence relating to improvement or deterioration in national physique from early times, and more especially under industrial conditions. Referring to the recent recruiting experience in Britain, he rightly points out that the National Service Survey of 1917–18 covered a population from which the best physical material had already been taken, and the marked inferiority in the average stature deduced from these returns as compared with that of recruits of British parentage drafted from the United States may be partly due to this fact, but also no doubt to the tendency of the best physical types to emigrate. School medical and recruiting data agree in showing the inferiority of the industrial as compared with the rural populations both in stature and general physique, but we are told that there is little or no evidence of deterioration of any one racial type in either respect since the beginning of the industrial era, but rather the reverse. The great increase in the expectation of life at the younger ages, which has undoubtedly occurred since Roman times, has been accelerated in the last two decades, as shown by the most recent life tables. The falling death-rate and improved health of the towns must be largely due to gradual removal of adverse conditions of labour, housing, and sanitation, which probably reached their worst level early in the last century, with the consequent stamping out of certain epidemic diseases and reduction in infant and adult mortality.

To proceed from this, however, to draw the conclusion that we are therefore physically and mentally a fitter race is only, it may be urged, to create a false sense of security. The evidence that there has been an advance in physical and mental characters at all comparable with the improvement in environment, if at all, is most inconclusive, though it cannot be doubted that such changes are making the race happier. The ten ency of public health measures to aid the survival inferior stocks may on the contrary have the rever effect, and the declining fertility and marriage rate the classes with the best physique in recent years is matter of serious import for the future. Such euger considerations, which are of primary importance in t determination of national physique, are scarcely giv their full weight in the address, and its optimistic to will not appear to all students of racial problems be justified by the facts.

The closing plea for an extension of anthropometr investigations in Britain, using the term in its wid sense, is, however, well worthy of consideration, for, quote from the address, "it is only on the basis careful physical and mental surveys that legislati directed towards social and racial hygiene cou properly be introduced and rightly justified." Wh the Board of Education refuses to countenance t loss of half a day's education for the purpose of anthropometric research on modern lines on t adolescent boys of a London school, one can on conclude that Britain has not yet awakened to the fa that the lack of such information in this country is deplorable handicap to the intelligent discussion such questions.

Specific Treatment of Infections by Artificia Remedies.

For his presidential address before Section (Physiology), Dr. H. H. Dale chose for his subje "Progress and Prospects in Chemotherapy," which l defined as the specific treatment of infections b artificial remedies. He showed how recent investig tions have attempted to solve the difficult problem the method of action of specific remedies. The vie that a drug acts as a direct poison to the parasite is qui insufficient, as also is Ehrlich's doctrine that in order be specific a drug must have a maximal affinity for t parasite and a minimal one for the tissues of the hos It is becoming increasingly evident that drugs a favourably not only as a result of any action they ma have on the parasite, but by virtue of the response the tissues of the host. Ehrlich and Shiga showed tha Trypan red would cure a mouse infected with *Trypan soma equinum*, but that it failed in the case of t guinea-pig, rat and dog infected with the same trypan some. Similarly Bayer "205" rids mice of trypan some infections but is much less active in the san trypanosomes in the ox and horse.

It is evident that the host factor plays an importar part in the curative process. Ehrlich found during h experiments with atoxyl that strains of trypanosom became resistant to the drug, and that this was mair tained though the virus was passed through a long seri of mice. Mesnil and Brimont, however, showed tha if the virus was passed into the rat it was no longe resistant, though when again inoculated into mice th resistance became at once apparent. It would seer that the trypanosomes in the mice had become toleran not of atoxyl itself but of some product resulting fro the action of atoxyl on the tissues of the mouse, thoug still remaining susceptible to a similar substance de rived from the action of the drug on the tissues of the ra

Neither Trypan blue nor Bayer "205"—and this is e of many other specific remedies—has any visible icity for trypanosomes when applied to them *in o*, though some physiological change is brought about demonstrated by a loss of virulence. Salvarsan has lethal action on spirochætes or trypanosomes *in o*, but after reduction to the corresponding arsenoxide is intensely toxic to them. Voegtlin and his co-rkers have produced evidence that such a reduction oxidation resulting from contact of the drug with the sues of the host accounts for its remarkable action in rochæte and trypanosome infections. Levaditi monstrated that atoxyl became lethal to trypano-nes *in vitro* after it had been incubated with an ulsion of liver, and he supposed that the actual ative agent was a substance "trypanotoxyl" result-from a combination of atoxyl with some constituent the liver or other tissue. Similarly, the therapeutic ion of bismuth salts was attributed by Levaditi and olau to a similarly produced "bismoxyl." Voegtlin s shown that the toxic action of the organic arsen-ides on trypanosomes and host tissues is depressed various sulphydrile compounds are injected simul-neously with the drug, and as a result of the work of pkins he has suggested that the resistant strains erred to above may be due to the trypanosomes ving acquired a capacity for producing such sulphy-dle compounds in excess of their vital needs.

Another illustration of the participation of the sues of the host is seen in the case of emetin in amœbic sentery. The alkaloid has no action on the amœbæ *vitro*, but is endowed with remarkable therapeutic perties when administered to human beings suffer-ig from this infection. It appears to have little or action on the same infection in cats. Whether the ug so affects the human tissues that they are no longer pable of affording nourishment to the amœbæ, or ether the amœbæ themselves are weakened so that ey fall victims to the natural protective power of the st are problems which still await solution. Morgen-th has expressed the opinion that quinine acts in alaria by combining with the red blood corpuscles d so rendering them unsuitable for invasion by the ung parasites.

The tissues of the host may influence the action of a ug in another way. They may fix the drug so that rapid excretion is prevented and by a gradual libera-n of small quantities of the drug itself, or of some bstance they have elaborated from it, prolong the tion on the parasite. Morgenroth has shown that 'Rivanol" is fixed by the red blood corpuscles or bcutaneous tissues and in inflammatory conditions e to streptococci it is gradually given up and retards e development of the cocci. Similarly Bayer "205" held up in the body for long periods, for animals nich have received a dose of the drug are protected ainst infection, while the serum of such an animal may tually bring about a cure in one already infected. has been shown that Bayer "205" enters into com-nation with certain constituents of the blood which thereby altered in character.

It is along lines such as these that chemotherapeutic vestigations are being conducted, and though in any cases it has appeared that specific remedies have en discovered empirically, during recent years advances have been made which go far towards affording a rational explanation of the various mechanisms involved in their action and which, in the future, will yield results of importance from the point of view of practical therapeutics.

Purposive Striving as a Fundamental Category of Psychology.

Psychology is something of a newcomer among the sciences, so that it is not surprising that there should be doubt about its standing among its older sisters. Psychologists are not quite sure what it is that they are studying, or how they should study it. Some of them doubt whether their subject is a branch of physical science at all; others think it would be valueless if it were not. Prof. W. McDougall devotes his presidential address to the Psychological Section to reassuring his faint-hearted colleagues. He insists that it is the business of the psychologist to study his subject by any and every means within his power, without casting side glances at what the students of physical sciences are doing or troubling about what they may be thinking about him. Above all, he should not restrict the scope of his inquiries for the sake of preconceptions about what is correct scientific procedure; the end will justify the means. He rebukes equally the "behaviourists," who want to confine themselves to purely physical methods, and the subjective school, who refuse to make use of observation of physical processes. He rebukes also those who try to belong to both schools with the help of the doctrine of psycho-physical parallelism.

Prof. McDougall conceives of psychology as the study of human nature, and therefore psychologists must take account of all the facts of human nature whether they like them or not. No intelligent discussion of human affairs is possible, as he points out, without the use of such terms as motive, intention, desire, will, responsibility, aspiration, ideal, striving, effort, interest, all of which involve the notion of purposiveness. Any system of psychology which excludes such a notion or explains it away is doomed to sterility and can never find much application to practical affairs. Applied psychology is now a reality both in medicine and industry. Those who have been successful in this field have not been doctrinaire "behaviourists" or subjectivists, but observers who have been ready to study the facts in any way they could and leave the theories to look after themselves. This is very sound advice of Prof. McDougall's, and might well be taken to heart by students of all possible branches of knowledge.

Physiological Aspects of Parasitism.

In his address to Section K (Botany), the president, Prof. V. H. Blackman, dealt with the relationship of host and parasite and their mutual reactions. The differences between animal and plant pathology were first noticed, notably that relating to disease-resistance. In animals, the resistance mostly studied has been acquired immunity, a type not known in the plant world, where the resistance existing is natural immunity. Whatever be the behaviour of individual

cells in plants after a parasitic attack, there is no acquired resistance and no general bodily reaction to disease, hence the application of serum therapy would appear to be precluded. Even if such sera could be prepared, there would be the difficulty of transmitting the substances throughout the plant-tissues and the passing on of the immunity acquired to the new organs which are constantly developing.

With regard to the processes concerned with the achievement of parasitism in plants, the two chief modes of entry, apart from wounds, are through stomatal pores or by actual penetration. The entry through the stoma is clearly the most facile one (though the nature of the reaction which brings it about is still obscure), and it is somewhat of a biological puzzle that any germ-tube should follow the hard road of epidermal penetration. The probability of a negative chemotropism of the germ-tube to its own waste products playing any considerable part in the process does not appear to be very strong, and the evidence for a positive chemotropism to substances diffusing from the host cells is insufficient. It would seem, therefore, that a contact stimulus must play the major part, though it is unlikely that thigmotropism (stereotropism is suggested as a more satisfactory term) is alone responsible for penetration. With regard to the actual mechanism involved, Prof. Blackman and his colleagues have put forward strong evidence for the view that the process is purely mechanical and that enzymes play no part.

The elucidation of the quality of natural infection has been studied particularly in the Erysiphaceæ and Uredineæ. In the latter group, Biffen and his colleagues have shown that resistance in *Puccinia glumarum* in wheat is really the result of hypersensitiveness. The mesophyll cells of the resistant variety are readily infected, but the infected cells react so violently that they are killed and the invading parasitic hyphæ with them. Hypersensitiveness has been shown by Stakman to be the key to resistance of American wheats to *P. graminis f. tritici*. There is no recovery of attacked cells and no production of antibodies either in susceptible or resistant forms. The difference in the behaviour between the cells of the two classes must lie in the differences in the normal physiological processes. Hence this aspect of plant pathology is dependent for its advance on plant physiology.

Academic Freedom.

Principal Ernest Barker's presidential address to Section L (Educational Science), on "The Nature and Conditions of Academic Freedom in Universities," is opportune and much to the point. For one thing, the remarkable growth of modern universities in England in the last two decades has raised the question of academic freedom in a new form, and for another, a little clear thinking upon a subject with so many ramifications is very desirable. Dr. Barker realises the "tangled web of environment" in which the modern university is placed, and does something to unravel it. His analysis is clear, logical, and thorough. At the outset he makes a very proper distinction between the freedom of the teacher and that of the university. He then proceeds to discuss each separately and in some detail.

Perhaps the first part of Dr. Barker's discussion will prove more interesting to the average university teacher than the second. In it he deals with the freedom of the teacher, and, true to his own principles, does not hesitate to express himself with that frankness and freedom which he desiderates. He raises many points and has something of interest to say on most of them. While we may agree with him that a "professor is wise to be severely moderate and master of himself," he will probably agree with us that such wisdom, without occasional relapses, would make academic life, to say the least, somewhat dull. Again, while we may agree with him that "it is difficult to be at once a publicist and a scholar," he will probably agree with us that if professors had become publicists only "in the gravest emergency," public life would have been much the poorer for the limitation. His remarks upon the difficulties which may arise in handling such subjects as history, government, economics, and modern languages are specially pertinent, and it may well be true, as he seems to think, that the cause of academic freedom in the future will be fought with regard to chairs connected with the subjects of politics and economics.

It would have been interesting to have had Dr. Barker's views on university teachers as parliamentary candidates. He seems to think that such candidatures raise "desperate difficulties," but does not state what these difficulties are. Perhaps they are not so great as he thinks, and it may be that there would be advantages largely outweighing them. Here it would seem that Dr. Barker, contrary to his usual practice, passes over an important issue, and one which will become increasingly important in the future. Again, it is curious and apparently illogical for so doughty a champion of academic freedom to suggest that the professoriate should elaborate and *enforce* among themselves a code of professional conduct. It would be immensely interesting to attend a conference or council which set out to draw up such a code! With two qualifications Dr. Barker, so far as the individual professor is concerned, is in favour as a general principle of freedom uncontrolled by any assumption of responsibility by the university.

With regard to the second part of the address dealing with the broader question of the freedom of the whole academic community, Dr. Barker, after a short historical reference, confines himself largely to the discussion of university finance and its general effect upon academic freedom. Here, again, the whole position is thoroughly probed and its many implications carefully considered. The whole address is thought-provoking, exceedingly well handled, and a distinct contribution to a subject of vital importance.

Printed in Great Britain by R. & R. Clark, Limited, *Edinburgh.*

NATURE

SATURDAY, AUGUST 16, 1924.

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2859, VOL. 114]

Crystals and Cells.

UNTIL very recent years, the addresses of presidents of Sections of the British Association were never made subjects of formal discussion. The address delivered on Monday, August 11, by Sir William Bragg to Section A (Mathematical and Physical Science) of the British Association meeting at Toronto departed from the former custom in being an introduction to a joint discussion with Section B (Chemistry), on crystal structure. Sir William Bragg explained how X-rays have made it possible to analyse the structure of crystals, thus opening up the chemistry of the solid. The X-rays tell us the number of molecules in the crystal unit and the mode of their arrangement, on which, of course, many properties of the substance depend. It may be noted that just as there are *atoms* of silicon and of oxygen, and a *molecule* of silicon dioxide, so there is a *crystal unit* of quartz consisting of three molecules of silicon dioxide arranged in a particular way. There are thirty-two classes of crystals, according to the kind of external symmetry which they display; but now that he can look into the interior of the crystal, Sir William Bragg finds that there are 230 different modes of internal arrangement. This is a new kind of crystal-gazing.

It has often been asked why a crystal should grow ("Lapides crescunt," said Linnæus) in a solution, especially when the substance in solution is different from that of the crystal, though crystallising in the same style of architecture. There is a welcome beam of light in Prof. Desch's paper on the crystal surface, for it shows that the aplomb of the atoms on the space lattice of the interior, where they are held in position by forces symmetrically disposed, is not shared by those on the surface layer, where there is surface tension and a welcoming, so to speak, of support by accretion from without. At high temperatures, it is noted, the surface tension may be sufficient to cause rounding of the sharp angles of a crystal.

The key-note of the Toronto meeting seems to be "control," for we find Prof. F. W. Gamble, in his presidential address, telling the zoologists that "zoological problems have become problems of control," not so much in the way of restraint as of "quickening." "The infinitely varied animal fabric appears to be the exquisitely balanced individual expression of processes that quicken and restrain." "If to succeed is to come up from below, the actual animal life that succeeds must be but a fraction of the submerged recessive life that experiment reveals. These recessives when artificially bred are no mere cripples, nor disconnected with the evolution of normals. They show us something of the depths of animal nature, and help us to realise that

but for the grace of organic regulation we should be even as they. But the study of such analysis as a branch of zoology leads to an even more striking result. Not only does it reveal the existence of these sub-normals, but also it accounts for the defection of certain expected offspring. There are non-viable combinations of living substances. These entering the egg that should by expectation produce a male, render the egg incapable of development. That family will be one of daughters only. The existence and the control of lethal factors is one of the most significant discoveries of the underworld."

Prof. Gamble is a strong swimmer and he led his audience into deep waters in his discussion of Prof. Child's hypothesis of metabolic gradients. That is to say, there is in an animal like a Planarian worm a gradation in the intensity of chemical change or metabolism from the head backwards. The rate increases again at a point far down the body and then falls to the tail-end. The second, smaller peak marks the place where the worm divides transversely in its asexual multiplication; it marks the site of the future head of the coming daughter! Prof. Gamble regards the suggestiveness of the evidence in support of the gradient hypothesis as exceeding its conclusiveness for the time being. He goes on to discuss with insight the periodicity of vital functions, the problem of nervous control, the control of environment, and the lightening of the eyes that will come when people take zoology seriously.

In his address to Section M (Agriculture), Sir John Russell discussed "Present-day Problems in Crop Production." One of the big conclusions that has emerged of recent years is that the plant is an even more plastic organisation than we thought; it can be moulded to a notable extent, though within certain—very uncertain—limits. One way of doing this is the Mendelian method of picking out desirable unit characters from plants in which they occur and assembling them in a new plant. The other way is selection, in which a desirable plant is caused to produce seed from which stocks are multiplied. A second generalisation is that the soil is not a fixed, constant thing, but is pulsating with change. The micro-organisms fluctuate continually, and even the mineral part of the soil is not constant in composition. "Modern research work shows that many of the properties determining fertility in soils are due to the soil colloids, and some of the most important are attributable to calcium complexes. These are unstable and are affected by the soil water."

Sir John Russell spoke of the control of the plant, the control of environmental factors (for example, by high-tension electric discharge), the control of soil factors, and the control of soil organisms. But he sounded another note, too seldom heard in the utilitarian days; he spoke eloquently of the value science for its own sake. "How many farmers kno anything about the remarkable structure of the so they till, of its fascinating history, of the teemin population of living organisms that dwell in its da recesses, of the wonderful wheel of life. . . ." "N one knows much of these things; but if we knew mor and could tell it as it deserves to be told, we shou have a story that would make the wildest romance human imagination seem tame by comparison, an would dispel for ever the illusion that the country a dull place to live in." This is well said. Trust th agriculturist, fundamental utilitarian as he is, to b loyal to the life that is more than meat.

A familiar experience at meetings of the Briti Association, especially if one wanders out of "one own Section," is a coercive abandonment of facts an conclusions which one had treasured as absolute certain. This holds for the Toronto meeting. Th it used to be common teaching that the earliest Pr Cambrian rocks represented the original crust of th earth, formed as it cooled from a molten to a sol condition. This was a comfortable view, for it ga one, so to speak, a geological jumping-off place. B Prof. A. P. Coleman has punctured our illusions in h paper on "Pre-Cambrian Climates." For it seem that there was before the Cambrian a long period desert conditions and a making of red sandstones before that was a time of cool moist climate and making of grey carbonaceous slates; and before th there was a Huronian Ice Age. "Below this, after profound break, is the Sudbury or Timiskaming serie mostly of water-deposited materials, including 40 feet of well-banded greywacke and slate, evidently seasonal origin. This gritty but well-establishe material and some boulder conglomerates make o suspect a cold and perhaps glacial climate." So th story runs; and the Pre-Cambrian basis, once regarde as primordial, is shown to have behind it a stupendo history.

It is well known that two forms of digestion—intr cellular and extra-cellular—occur among animal Intra-cellular digestion, where the food is taken in ingestive cells and then digested, occurs, as Mr. F. Potts points out, in sponges, stinging animals, fl worms, and molluscs, often accompanied, however, b the extra-cellular method where the secretion of digestive juice dissolves the food in the cavity of th food-canal. The latter is the exclusive method Annelids, Arthropods, Echinoderms, and some small phyla. "In the Gastropod Molluscs digestion in th flesh-eating forms is mainly extra-cellular; in th

vegetarians it is largely intra-cellular." In some cases of specialised diet the intra-cellular method is prominent, as Mr. Potts illustrates by the case of the wood-boring Teredo. In some wood-eating Arthropods like termites, in which there is no intra-cellular digestion, the function has been taken over by symbiotic Infusorians.

In an interesting study of sex-development in fowls, Dr. F. A. E. Crew propounds the view that the genetic constitution of the individual determines what may be called the internal environment in the direction of "femaleness" or of "maleness." "In an internal environment of 'femaleness' the embryonic gonad becomes an ovary, in one of 'maleness' a testis. The bird has an ovary because she is a female, a testis because he is a male. The type of plumage is determined by the type of metabolism which obtains at the time of its development, and is not a response to any specific influence of an internal secretion elaborated by the differentiated gonad." The physiological theory of sex, championed by Geddes and Thomson long ago, is having its innings.

Dr. F. A. Dixey's paper on the minute scent-distributing structures in white butterflies is of noteworthy interest. There are secretory cells and distributing scales. The scent-distributing scale is usually a rather highly specialised structure, often in the form of a flattened lamina provided distally with a fringe of chitinous filaments, and proximally with a fine flexible footstalk. The latter expands into an accessory disc, very varied in size and character. The disc is inserted into a specialised socket, within or beneath which are found the cells that secrete the scent. Everything is so minute that it is difficult to be sure how the scent escapes. Dr. Dixey finds no convincing evidence of pores, and inclines to Weismann's view, that the scented material passes from the secretory cells into the disc, the footstalk, and the lamina.

The physiologists continue to discover new rôles for hormones. Thus Prof. W. B. Cannon and Dr. A. Querido find that adrenal secretion is increased in animals when there is liability to lowered temperature by heat loss. The increased secretion brings about an increased metabolism, a chemical calorigenesis, quite apart from the muscular movements of shivering. So the animal has two distinct lines of defence. In another paper by Prof. A. T. Cameron, Dr. T. Ingvaldsen, and Dr. J. Carmichael, evidence is brought forward to support the view that the internal secretion of the thyroid is a compound of thyroxin with some other radical which considerably increases its activity.

Prof. H. Wasteneys and Mr. H. Borsook have succeeded in effecting the enzymatic synthesis of protein in peptic digests of albumin. The maximum synthesis so far obtained has been 39 per cent. There is "incontrovertible evidence" that the material synthesised is of the order of complexity of native proteins. The enzyme responsible for the synthesis was found to be inseparable in every respect from the enzyme effecting the hydrolysis of proteins.

Every one is familiar with the feeling of having seen the same thing before, though one knows that it could not be so. This is the phenomenon of "déjà vu," which Grasset and Freud have explained as due to the activation of an unconscious memory of a real event, a fantasy, or a dream, which in some way resembles the coincident, conscious perception. The problem has been rediscussed by Dr. J. T. MacCurdy, who has found a somewhat analogous pathological phenomenon —the perplexity case—apparently with a similar obsessive suggestion of familiarity. As often happens, the pathological throws light on the normal.

Prof. G. H. Parker has been able to determine the amounts of carbon dioxide excreted by the lateral line nerve of the dog-fish, the sciatic nerve of the frog, and the ventral nerve cord of the lobster. The quiescent frog nerve produced on the average nine-thousandths of a milligram of carbon dioxide per gram of nerve per minute. In active nerve this was increased by about twelve per cent. Weight for weight, the resting frog nerve produces about the same amount of carbon dioxide as the resting human body does.

These, however, are scarcely more than random comments upon a few of the extraordinarily interesting series of addresses and papers presented at Toronto. A more adequate survey of the wide range of subjects brought before the various Sections must be reserved for later issues.

The Metallurgy of Iron and Steel.

(1) *Lehrbuch der Eisenhüttenkunde: verfasst für den Unterricht, den Betrieb und das Entwerfen von Eisenhüttenanlagen.* Von Prof. Dr. Bernhard Osann. Zweite neubearbeitete und erweiterte Auflage. Erster Band: Roheisenerzeugung. Pp. xi+923. (Leipzig: Wilhelm Engelmann, 1923.) 29*s*.

(2) *The Metallurgy of Steel.* By F. W. Harbord and J. W. Hall. (Griffin's Metallurgical Series.) Seventh edition, thoroughly revised. Vol. 1: Metallurgy; by F. W. Harbord. Pp. xii+545+41 plates. Vol. 2: Mechanical Treatment; by J. W. Hall. Pp. xv+553+42 plates. (London: C. Griffin and Co., Ltd., 1923.) 32*s*. net each vol.

WHILST primitive methods of making malleable iron or steel were mainly conducted in such a way that the product was obtained directly from the

ore without a preliminary fusion, almost the whole of the modern product is obtained in the first instance as pig-iron, a readily fusible mixture of iron with carbon, silicon, and other elements derived from the ore and the fuel, these impurities being afterwards removed by processes based on differential oxidation. This round-about method has proved in practice to have such great advantages, both chemical and economic, that it has become the universal practice. Attempts now being made to re-introduce the old direct process in a greatly improved form have to contend against the fact that smelting in the blast-furnace, at first sight a crude device for extracting iron from its ores, has reached a condition of high efficiency, making it very difficult for a new process to prove any superiority in economy, whatever its apparent theoretical advantages.

In spite of the fundamental importance of the blast-furnace, it has received less attention from scientific metallurgists than the processes for converting its product, the crude pig-iron, into steel. It is true that the pioneer work of Playfair and Lowthian Bell, which gave a scientific basis to the chemical process of ore reduction, has been followed by many interesting researches on the equilibrium between iron, its oxides and the oxides of carbon, but even these reactions are not yet perfectly understood, and most improvements in the operations have been made empirically. Such scientific work as has been done is mostly German, and Prof. Osann's book (1) is greatly superior to works which are little more than catalogues of plant.

The new edition of this treatise, which is the first volume of a comprehensive work on the metallurgy of iron, is of very great interest. Its attractive form and its 550 admirably clear illustrations will make it popular, and it contains information of a detailed kind on the construction and working of the blast-furnace and on such closely connected subjects as the preparation of coke and the utilisation of blast-furnace gas. Certain limitations should be recognised. German, and to some extent American, practice is described, but references to the practice in other countries is only occasional, and not always accurate; the map of the British coalfields on p. 115, for example, failing to show coal in either Yorkshire or Lancashire, and being erroneous in several other respects.

With very few exceptions, all references to literature are taken from *Stahl und Eisen*, so that the remarkable work of the Geophysical Laboratory of Washington on the constituents of slags, the equilibrium diagrams of which are reproduced, is attributed to the writer who abstracted the publications for that journal. The interesting survey of the economic conditions c iron production in the principal countries of the worl is dated 1913, the author stating that the presen conditions are so chaotic as to make a systemati review impossible.

In addition to its character of an encyclopædia of th construction and use of the blast-furnace, the work i remarkable for the amount of space given to calcula tions. An effort has been made to give a quantitativ treatment of every aspect of the industry, and this par of the work is to be highly commended. The studen will find it a profitable exercise to work carefully throug a number of the calculations given by Prof. Osann, an in so doing will be impressed by the necessity for main taining exactly the balance between a number of factors on which the efficiency of the furnace depends. Th English reader will do well to compare the importan paper by F. Clements in the Journal of the Iron and Stee Institute for 1920, in which he will find the quantitativ data for English blast-furnaces, worked out in deta with all the necessary information for determining th efficiency. With such material before the student there is no longer any excuse for the academic neglec of the subject of the smelting of pig-iron which has s long prevailed.

There are some defects in the arrangement of th book, a subject being sometimes cut up into separat sections, which are scattered through different chapter without apparent reason. The full table of content and good index make this defect less serious, althoug irritating. Casting in the pig-bed only receives a fe lines, although machine casting in moulds is rather mor fully described, and it is not clear why so essential part of the process should be neglected. The physica chemistry of the work is rather weak, and occasionall some bad mistakes are made, as in the account o "mixed crystals" on p. 622, but a real attempt ha been made to give an account of the chemistry of iro smelting, and the survey of the chemistry of slags i more satisfactory. Revision of the purely scientifi sections by a physical chemist would be of advantage but with this reservation the book may be recommende to metallurgists generally.

(2) The seventh edition of this, the most importan English text-book on the manufacture of steel, is greatl enlarged, and now forms two massive volumes, whic are sold separately. Since its last revision, progress i the design of plant, in methods of working, and abov all in the scientific understanding of technical processes has made changes in the presentation of the subject t students very necessary. To revise a work of such wid scope, full of illustrations and tables, is naturally difficult matter, and it is perhaps not surprising to find

hat the revision of the first volume, especially, leaves nuch to be desired.

To give a clear and systematic account of the industry s it exists to-day would have meant the complete re-riting of much of the book, and the easier plan, of nterpolating new material at intervals and revising ortions only, has been adopted. The consequence is hat whilst the new edition of Harbord and Hall must etain its place as the standard work of reference on he metallurgy of steel, the serious student or practical teel-maker will often turn to it in vain for information s to the practice or knowledge of the present day, and t other times will find descriptions of processes or tatements of theory which are antiquated, using he word in the relative sense which is natural in onnexion with a subject which makes such rapid dvances.

The defect is most noticeable on the scientific side. he accounts of the physical chemistry of the iron-arbon system, and of the influence of temperature nd other conditions, including the presence of foreign lements, show the grafting of fragments of new know-dge on to the old stock, whilst the student of to-day eeds a clear summary of the state of existing know-dge, incorporating the discoveries which have been eached by modern methods. In a work which is less istorical than practical, it is disappointing to find so uch space given up to dead controversies, the interest which has disappeared owing to the introduction of ew methods. For example, the rival views as to the ature of β-iron and its part in the hardening process ave ceased to be of interest since magnetic observa-ons and, above all, the method of X-ray analysis have moved all doubt on the subject. For the same reason n account of the modern method of preparing micro-ctions would have been preferable to the long record f methods employed by successive investigators with ss perfect technique. Moreover, the scientific study f the relations between the components of molten pig-on and the oxidising agents which bring about its nversion into steel has made immense progress, which ceives no attention in the work before us, the old ermochemical equations which served as a rough uide representing only a part of the story. A good rvey of this important field is still lacking, although nglish chemists have contributed much by their vestigations.

Closely connected with this subject is the question f the distribution and influence of segregated im-urities and of non-metallic inclusions, the importance f which in determining the quality of steel is now fully cknowledged. The evils due to these causes may be rgely eliminated by the choice of suitable methods of casting; but on this matter scarcely any information is given, and the student will have to refer to other works. Another section calling for drastic revision is that dealing with alloy steels. This branch of the industry has developed so rapidly as to make the information given in earlier editions obsolete, and it would have been better to omit the accounts of early work, except so far as is necessary to present the historical aspect of discovery, and to replace them by a modern statement of the alloy steels actually found in use, with a scientific account of their heat treatment and of its relation to constitution. The fact is that the steel industry has passed beyond the stage of empirical control, and has become scientific, and no text-book can be regarded as quite satisfactory which does not indicate the connexion between science and practice. It is to be hoped that a bold effort will be made in the preparation of the next edition to remove obsolete matter, and to replace it by descriptions more nearly representing the actual state of metallurgical science.

The second volume, dealing with the mechanical treatment of steel, is not open to quite the same objections. Such treatment is still mainly empirical, and the scientific calculation of stresses in rolling and forging has only been undertaken by a few persons, whose work is not very generally known. The account of modern plant is adequate, and constitutes a valuable collection of practical information. The chapter on wire, especially wire for ropes, fails to represent modern practice, but in the main new processes are well described. The position of this well-known text-book in metallurgical literature is a deservedly high one, and it has been thought well to direct attention to its shortcomings, in the hope that they will be remedied.

C. H. D.

High Frequency Spectra.

Spektroscopie der Röntgenstrahlen. Von Prof. Dr. Manne Siegbahn. Pp. vi+257. (Berlin: Julius Springer, 1924.) 3.60 dollars.

OF the many fields of physics which have been extensively explored during the past decade, none, perhaps, has yielded a greater contribution to our knowledge of atomic structure than that of X-ray spectroscopy. Since the classical experiments of Moseley in 1913–14, the development of the subject has been rapid, and we have now at our disposal a very extensive knowledge of the X-ray emission and absorption spectra of the elements. The time was therefore ripe for the publication of a volume devoted, almost entirely, to a discussion of the methods and results of

X-ray spectroscopy. The present monograph is all the more welcome as coming from the pen of Prof. Siegbahn, who has contributed more than any other to the development of the technique of accurate wave-length measurements in this region of the spectrum.

Prof. Siegbahn's attitude towards his subject is essentially that of the experimental physicist. His main object is to give a full account of the experimental data at present available, and from these to deduce the laws governing the emission of X-ray spectra. Theoretical considerations are introduced in the interpretation of these laws, but throughout the volume the experimental side is emphasised and theory allocated to a secondary position. In such a volume it is natural to find a very considerable section devoted to detailed descriptions of the various methods used in the experimental work. These descriptions, accompanied as they are by excellent drawings and plates, will prove invaluable not only to those who are interested in the determination of X-ray wave-lengths, but also to all who wish to be acquainted with modern X-ray technique. The author is an acknowledged authority on this subject, and anything he has to say in this connexion is well worthy of consideration.

The discussion of the K,L,M, etc. series follows more or less conventional lines. Very complete tables of the latest accurate measurements are given, both for the emission and for the absorption spectra. At present the accuracy of the determination of X-ray wave-lengths must depend on that of other physical constants, but it is no small achievement that, after so short a time, it should be possible in many cases to determine relative wave-lengths to six significant figures. The author emphasises certain experimental work which has so far not received attention in other books on the subject. Most noticeable, perhaps, in this connexion, is the account of the remarkable experiments of Lindh and others on the dependence of the absorption bands of such elements as chlorine and sulphur on their state of chemical combination. This is the first definitely established case of the influence of molecular combination on these phenomena. Now that it has been shown that the valency of the atom in the molecule affects the position of the edge of its absorption band, physicists and chemists alike will await with interest further work in this direction. The whole treatment of the absorption and emission spectra is excellent. Not only are tables of wave-lengths given but also of frequencies (ν/R and $\sqrt{\nu/R}$); a few obvious inaccuracies have crept into these tables, but they are not such as are likely to lead to any confusion.

An admirable section is devoted to the more theoretical side of the problem. Mathematical treatment h been avoided, but the description of the principles la down by Bohr and Sommerfeld is sufficient to enal the reader to follow with interest the extraordinari successful manner in which theory has kept pace wi experimental progress. The existence of doublets constant frequency difference, the connexion betwe one series and another, the variation of frequency wi atomic number and other properties of X-ray spectr are discussed and shown to be natural consequences Bohr's atomic model. From the experimental dat Prof. Siegbahn demonstrates how it is possible determine the various energy levels in the atom, and hc the levels so determined provide a remarkable confirm tion of the distribution of the electrons in the ato suggested by Bohr from other considerations. The fa that all the lines which these energy levels suggest possible do not occur in the observed spectra is shov to lead to a selection principle similar to that whi holds for the visible spectrum. The author has be most successful in his endeavour to present the theore cal aspect of his subject with a maximum of simplicit The reader can scarcely fail to be impressed by tl remarkable way in which a theory, formulated initial to explain the visible spectrum, is shown to be immec ately applicable to a region of the spectrum where tl frequencies of the radiations are some ten thousar times greater. Prof. Siegbahn makes it clear th much work still remains to be done before all the fac described in the earlier chapters are satisfactori interpreted. Particularly interesting, as a suggestic of further lines of development, is his account Wentzel's attempt to explain the more complicated spectra of the lighter elements as due to the existence atoms from which more than one electron has bee removed.

In the concluding chapters the author deals with tl " white " radiation and with the more indirect metho which have been applied to X-ray spectroscop especially with the determination of energy levels b means of β-ray spectra and ionisation potentials. Tl work in the latter direction has been most successf in helping to bridge the gap between the X-ra region and the extreme ultraviolet. In the form appendices are given some useful tables and a excellent bibliography.

Prof. Siegbahn is to be congratulated on having pr duced a volume which is not only a necessary additic to the library of the X-ray specialist, but is also t be heartily recommended to all who are interested i the advance, experimental and theoretical, in on of the most productive fields of modern physic research.

Lord Avebury's Life and Influence.

The Life-work of Lord Avebury (Sir John Lubbock), 1834–1913. Comprising Essays by Sir Bernard Mallet, Sir Arthur Keith, Dr. A. Smith Woodward, Prof. J. Arthur Thomson, H. St. J. K. Donisthorpe, Dr. A. C. Seward, Sir Michael E. Sadler. Edited by his daughter, the Hon. Mrs. Adrian Grant Duff. Pp. vii+261. (London: Watts and Co., 1924.) 6*s.* net.

THE book under notice contains a short memoir of the late Lord Avebury, and a series of appreciations of his very numerous activities by seven experts. Lord Avebury was an interesting personality, and he covered so many and so varied interests that it requires a symposium to estimate the value of the work he did.

The first of these experts is Sir Bernard Mallet, who dwells upon the political and economic work Sir John Lubbock did whilst he was a member of Parliament. When he was first invited to become a candidate he summed up the objects he wished to achieve as follows: "(1) To promote the study of science both in secondary and primary schools, (2) to quicken the repayment of the National Debt, and (3) to secure some additional holidays and to shorten the hours of labour in shops." It is remarkable how by quiet and steady persistence he in time achieved those reforms which he set out to accomplish. His name will ever be associated with bank holidays. Sir Bernard sums up his power as a politician as follows:

> Sir John Lubbock's whole attitude towards economic questions was characterised by the same sound judgment and common sense. He was, as I have mentioned, in full sympathy with the best economic opinion of his day on fiscal policy, Free Trade, municipal trading, and so on; and in his various addresses and articles on such questions his touch is so sure and confident that a reader might almost imagine that his views had been adopted wholesale from text-books. His scientific habit of mind, no doubt, combined with his practical experience of business, gave him more than ordinary facility in such matters: but he had furthermore the power observable in men of executive capacity of arriving rapidly and without any apparent process of thought at conclusions which, once formed, were apt to remain unquestioned in his mind. This probably accounts for his remarkable clearness in exposition.

Lord Avebury's remarkable achievements in anthropology are dealt with by Sir Arthur Keith. In the middle of the last century, from the late 'forties to the 'sixties, a small company of Englishmen with whom Lubbock was associated—he was quite a boy, for he entered his father's bank in 1849 at the age of 15—entirely revolutionised the idea of the history of man. Constant contact with Charles Darwin, a neighbour of his in Kent, had widened his outlook and that of his fellow-workers; and perhaps the most distinguished of the many distinguished pieces of work that Lord Avebury accomplished was in his "Prehistoric Times" and "The Origin of Civilisation"; both of these passed through repeated editions and are still classics. The words of Sir Arthur Keith are eminently true when he writes: "Let us have done, once and for all, with the prevalent notion that his books on the pre-history of man are the mere accomplishments of a clever compiler. He was an original thinker of a high order."

As a geologist Lord Avebury was chiefly interested in prehistoric man, and his geological publications were not highly specialised in other fields, but his knowledge of geology gave a good background to many of his widely read books. "The Scenery of Switzerland," for example, was much more than a mere compendium or abstract of the works of the Swiss geologists whom he quoted. He wrote from first-hand personal knowledge, and he always had an eminently readable style, so that this book has added greatly to the pleasure of the numerous frequenters of "the playground of Europe."

A very brilliant study of Lord Avebury's work as a zoologist is written by Prof. J. Arthur Thomson. Although his published monograph on the Collembola and Thysanura, an obscure group of insects, is still a standard work of reference, his chief fame rests on his amazing investigations into the behaviour of animals. He was, indeed, as Prof. Thomson says, "the pioneer of the experimental study of animal behaviour." His observations on the colour-sense of bees, the homing of ants and bees, and the behaviour of wasps started a new chapter in the history of experimental zoology. There is a special chapter dealing with his fascinating studies on ants by Mr. Donisthorpe.

Lord Avebury's researches in botany are dealt with by Prof. Seward, who recounts the ceaseless work which he did on the interrelation of insects and plants, the methods of pollination, the form of leaves, buds, and stipules, and last of all on seedlings. His love of beauty and his great gift of exposition are evidenced in all his writings, but nowhere more so than in his writings on the plants he loved so well.

Lord Avebury's business training doubtless enabled him to apportion his time so that no one minute was wasted. How one man could have got through so much, how he could have made so many researches and so faithfully investigated Nature in so many phases is difficult to understand. Doubtless he had many helpers. But this total output, as recorded and appreciated in this book on his life work, is literally amazing, especially when one remembers that he was actively engaged as a successful banker during most of his life.

Our Bookshelf.

The Cultivated Evergreens: a Handbook of the Coniferous and most important Broad-leaved Evergreens planted for Ornament in the United States and Canada. Edited by L. H. Bailey. Pp. xvii+434+48 plates. (London: Macmillan and Co., Ltd., 1923.) 31*s.* 6*d.* net.

THIS handsome volume was compiled for use in the United States and Canada by fourteen American experts in botany, horticulture, and allied subjects; but it will also be of service on the eastern side of the Atlantic, as nearly all the species dealt with can be seen in English parks and gardens. The great diversity of the British climate allows us to grow, in one part or another of these islands, an amazing number of exotic plants, imported from almost every region outside the tropics.

The greater part of the text is concerned with one class of evergreens, the Coniferæ; but the five genera, Larix, Pseudolarix, Taxodium, Glyptostrobus, and Ginkgo, which happen to have deciduous foliage, are not excluded on this account. The other class, comprising the broad-leaved evergreen trees and shrubs, seems to be more sparingly cultivated in the United States than in Great Britain; and only 25 species are selected for description, though some others are briefly mentioned. Acid soils, which are an essential requirement for the proper growth of a considerable number of broad-leaved evergreens, are the subject of a special article by Prof. F. V. Coville, whose experiments should greatly interest cultivators of Rhododendrons.

In the main part of the book, conifers are considered from nearly all points of view, except that of timber production. The use of the different species and varieties for ornament and shelter is the main consideration. A series of articles deal with their effects in the landscape, and their adaptability to different soils and situations. Other articles are concerned with modes of propagation, nursery management, cultivation, attacks of insects, diseases, injuries of all kinds, fungicides, tree surgery, etc. The information given on these subjects by the various experts contains many valuable hints on the choice, cultivation, and care of coniferous trees.

The botanical part of the work is due to Alfred Rehder, the systematist of the Arnold Arboretum. In this establishment there are fine collections, both of living trees and of dried specimens, which have enabled him to draw up accurate descriptions of the conifers in cultivation. He has also provided keys for the genera and species, which render identification easy, even in the absence of flowers and cones. The botanical descriptions are elucidated by nearly 100 engravings in the text. Conifers are very varied in form and colour; and their choice for landscape effect depends largely on a proper knowledge of the habit of each species and variety when fully grown. This is well illustrated by 48 full-page plates, which depict groups and individual specimens growing in New England. These plates are worthy of study by landscape gardeners.

A check-list of all the woody evergreens that are offered for sale in the United States is given at the end of the book, which will serve as a suggestive planting list. There is also an adequate index. We have no hesitation in characterising this handbook as a useful addition to the literature of conifers.

The Modern Theory and Practice of Pumping: a Treatise on the Application of the Reynolds-Stanton Law of Viscous Flow to Modern Pumping Problems and the Flow of Liquids through Pipes. By Norman Swindin. Pp. 364. (London: Ernest Benn, Ltd., 1924.) 42*s.* net.

THE first part of this work is devoted to a general consideration of viscosity, of the motion of viscous fluids, and of the resistance to flow in pipes, with special reference to the relationship between the many empirical formulæ of the exponential type which have been evolved in the past, and the dimensional formula of Reynolds.

The introduction deals briefly with the history of modern hydrodynamics, outlining the relationship between the behaviour of the perfect fluid of the mathematician and of a viscous fluid. Chapter ii. deals with industrial viscometry, with special reference to the liquids with which the chemical engineer may be required to deal. Chapter iii. gives a précis of Reynolds's discussion of the two manners of motion of a fluid, together with later extensions of the theory, and Chapter iv. gives examples of the application of the Reynolds's function in industrial problems. The treatment of this part of the book is excellent, and the various points of application to the problems of the chemical engineer are well brought out.

The second part of the work deals with the many types of pump in use for pumping corrosive, gritty, solid-laden, and viscous liquids such as are not in general handled by the hydraulic engineer. Chapters are devoted to the ram pump, the centrifugal pump, the rotary pump, the air-lift, the displacement pump, and to miscellaneous pumping appliances, particular attention being paid to those types which have been devised to meet special conditions.

While no great space has been devoted to a discussion of the theory of operation, this is adequate for the purpose in view. Special reference must be made to the section dealing with the air-lift pump. This forms one of the most satisfactory discussions yet published of this important but somewhat neglected type of installation. A chapter is devoted to pipe lines and fittings, and another to the pumping of oil for the oil fuel and petroleum industry. In view of the special difficulties involved in pumping such fluids through long pipe lines, this chapter is likely to be of much value.

The book should certainly find a place in the library of every chemical engineer, while engineers in general hydraulic practice will find much that is stimulating and of interest in its pages. It is well printed and excellently illustrated. A. H. G.

Thermochimie. Par Prof. F. Bourion. (Collection de Physique et Chimie.) Pp. xii+363. (Paris: Gaston Doin, 1924.) 25 francs.

THE science of thermochemistry owes most of its experimental data to the work of Thomsen, from 1853 onwards, in Copenhagen, and to the work of Berthelot in Paris from 1865. It was originally inspired by the

idea that the amount of heat liberated in a chemical action was a measure of the energy available from this source, but this is only correct at the absolute zero; at all other temperatures, therefore, endothermic actions can occur, and it is no longer possible to predict from the thermochemical data alone in which direction a chemical action will proceed. On the experimental side also, the science has been limited by a standard of accuracy far lower than can be attained in other physical measurements. This lack of accuracy is the more to be deplored since the heats of formation of organic compounds are based upon the differences between relatively enormous heats of combustion; and the most interesting data (*e.g.* the heats of formation of isomers) contain even larger percentage errors than the heats of combustion through which they are determined.

It is, however, of interest to know that recent developments, in the original laboratory of Berthelot, have led to a very great improvement in the degree of accuracy of the measurements. These are now being obtained within about 1 part in 1000 by using a completely enclosed apparatus, in which evaporation from the surface of the calorimeter and other disturbing factors are eliminated. It is therefore natural that interest in thermochemistry should once again have been aroused in France, and that the latest text-book on the subject should be of French origin. Prof. Bourion has not himself made any important contributions to thermochemistry, but he is familiar with the work that has been done by other investigators, and his book will obviously be consulted by all those who wish to know the present position of the subject.

La télégraphie sans fil : ses applications en temps de paix et pendant la guerre. Par Julien Verdier. Pp. viii + 412. (Paris : Gauthier-Villars et Cie, 1924.) 35 francs.

To every radio engineer who desires to learn the latest practical advances made in radio communication in France we can recommend this book. The historical introduction is not very good and has perhaps a national bias, while the theoretical chapter is too sketchy to be of use to any one but an expert. But the chapters describing practical applications, radio communication during the War, and the French radio stations, contain much novel matter. France has built the two most powerful stations in the world, Melun and Croix-d'Hins. The radio centre at Sainte-Assise is perhaps the most perfectly organised. Methods of using radio waves for discovering masses of metal near the surface of the earth are described. Many of the important radiograms issued during the War are now published for the first time, and the conversations between the Eiffel Tower and Nauen will be instructive to the future historian. The radiograms issued just before the Armistice are highly dramatic.

The French radio system is divided into three distinct services, (1) the Service of the Interior, (2) the Radio Maritime Service, and (3) the Colonial and International Service. The first, which is used for official, special press, meteorological, etc., messages and for time signals, relieves considerably the ordinary telegraph service. Broadcasting comes under this head. The Radio Maritime Service maintains communication with ships at sea and is regulated by the International Rules adopted at London in 1912. Full lists are given of the Colonial and International stations with which there is regular communication. In the last chapter, both the French and the International Rules for radio work are given in full.

Théorie générale sur les courants alternatifs. Par M. E. Piernet. (École d'électricité et de mécanique industrielles.) Fascicule 1. Pp. x + 100. (Paris : Gauthier-Villars et Cie, 1924.) 12 francs.

THIS book explains clearly the principal theorems of the theory of polyphase currents. The mathematical student who has a knowledge of French will have no difficulty in understanding it. The theorems given form an excellent basis which he can use for extending his knowledge. It will be useful, however, to make a few criticisms. When defining the instantaneous power in a circuit (p. 13) the author talks about the quantity of energy *instantaneously* given to the circuit. He defines also the watt current and the wattless current. The reader gets the impression that the current has more to do with the power than the electromotive force. A formal proof is given of the "equivalent" sine wave, and it is concluded that it can in general be used instead of the actual wave. Many practical engineers do make this assumption, but in some cases it will lead to very erroneous results. The so-called "equivalent" sine wave has a different area from the actual wave. The magnetic flux induced in a transformer, for example, when the two waves are applied at the primary terminals, will be different and so also will be the consequent losses in the core. The experimental method of analysing a wave is described, but we do not think that the analytical method given will be of much use. In the last chapter the theory of rotating magnetic fields is discussed in a way that will appeal strongly to the mathematician. Much of this book might with advantage be included as practical examples to illustrate the theory in a mathematical treatise on the calculus.

A Shorter School Geometry. By H. S. Hall and F. H. Stevens. Part 1. Pp. x + 164 + iv. (London : Macmillan and Co., Ltd., 1924.) 2*s*. 6*d*.

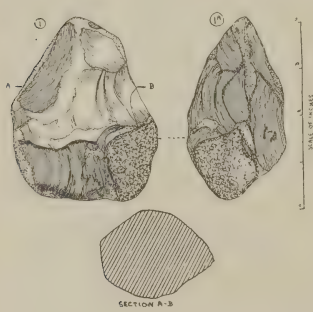
THIS volume is much more than a revised edition of the well-known course of "School Geometry" by the same authors : there are differences alike in matter, plan, and presentation so substantial that it may almost be regarded as a new text-book. The authors have followed many of the recommendations put forward in the recent report issued by a Committee appointed by the I.A.A.M. We notice, however, that they have included in the text "proofs" of the fundamental congruence theorems but have excluded "proofs" of the fundamental parallel theorems. This is a curious compromise which it is unlikely will stand the test of time. Both groups of fundamental properties are treated informally in an introduction which runs to 42 pages and also includes some mention of similarity; the latter, however, might with advantage be discussed in greater detail. There is much to be said for developing informally the general principle of similarity with as much emphasis as is now given to the general principle of congruence. The exercises have been increased in number, particularly those of a numerical character : the clearness of the type and the diagrams deserve a special word of praise.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Further Discoveries of Ancient Flint Implements at Cromer.

FOLLOWING upon the discoveries of flint implements referable to the Cromer Forest Bed Series of Norfolk, the Trustees of the Percy Sladen Fund very generously provided funds for the further examination of these and of other associated deposits. The first part of this research is now completed, and has, in my judgment, established the occurrence of flint implements of Early Chellean types at the base of the Cromer Forest Bed, and of Late Acheulean types in some of the glacial gravel above the Contorted Drift. As will be remembered, there was discovered upon the foreshore at Cromer a large series of ochreous specimens, which, while not actually *in situ*, was, from the whole circumstances of the case, referred by me to the lowermost horizon of the Forest Bed.[1]



FIGS. 1 and 1A.—Early Chellean hand-axe from foreshore, Cromer.

It was obviously necessary to endeavour to ascertain by digging if similar ochreous flints occurred in place in some deposit beneath the beach, between the foreshore and the cliffs, at the site where the discovery was made. Such excavations were attempted, but, unfortunately, the water-logged condition of the sand and shingle forming the beach was such as to make impossible any digging in a downward direction, and the work had to be abandoned. Associated with the ochreous specimens upon the foreshore, was found another series of artefacts of a totally different character. These latter flints are usually of a glossy black colour—giving them an appearance of having been black-leaded—and their forms and flaking are clearly divergent from the ochreous pieces.

The occurrence of large quantities of such flints upon the Cromer foreshore, beyond the seaward extension of the beach, is to be explained only on the supposition that, at one time, there existed a bed, or beds, containing these specimens, and that the action of the sea has gradually removed the ferruginous or other material forming the deposits, leaving only the heavier and insoluble residue of flints and other objects intact. This supposition is supported by the following facts. A prolonged examination of the contents of the beds forming the cliffs and the foreshore of the north-east coast of Norfolk has shown that the great bulk of the flints referable to these various deposits differ markedly, and that, for example, it is not possible to mistake specimens in the glacial gravels for those coming from the Forest Bed. Further, a considerable number of the foreshore specimens have, attached to some portion of their surfaces, the remains of a highly ferruginous sandy deposit, which clearly formed part of the bed in which at one time the flints were embedded. Moreover, upon the foreshore, exposed at low water at East Runton—about 2 miles westward of Cromer—there are to be seen large areas of a highly ferruginous bed, the sandy content of which corresponds precisely, in appearance, with that adherent to the specimens found at Cromer. Lastly, an examination of the East Runton deposit demonstrates that it contains implements and flakes comparable, both in colour and in technique, to the ochreous and to the black-leaded series of Cromer. The former assemblage is certainly not so deeply ochreous as that collected upon the Cromer foreshore, but this is a minor difference due, no doubt, to the fact that, at the latter place, the flint-containing bed was richer in salts of iron than that exposed at East Runton. The remains of this bed at this place are surrounded by large numbers of flints, such as occur upon the foreshore at Cromer, and it is abundantly clear that these specimens have been washed out of the deposit to which they lie in such close proximity.

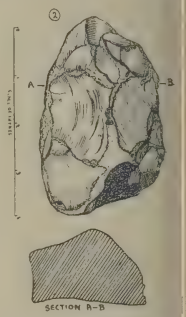
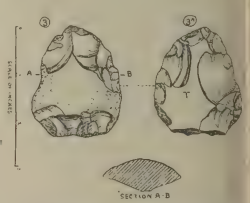


FIG. 2.—Early Chellean hand-axe from foreshore, Cromer.

There can be no doubt that this East Runton deposit, which rests upon the chalk, underlies (*a*) an accumulation, representing probably the Estuarine Gravel, containing large mammalian bones referable to the Cromer Forest Bed, and (*b*) the immense glacial deposits and chalk erratics exposed in the cliff at this spot. The implementiferous bed is about 18 inches in greatest thickness, and contains a large number of flints, many of which exhibit the well-known appearance of those found in the Stone Bed beneath the Weybourne Crag, together with pieces of quartz, fragments of bone, and some shells. In fact, at first sight, the deposit bears a very close resemblance to the Sub-Weybourne Crag Stone Bed, material from which it undoubtedly contains, but an examination of the contents leads me to believe that the accumulation must be referred to a later period than that of the Sub-Crag Stone Bed, namely, to the earliest Cromer Forest Bed Stage. Many of the flints found in the East Runton deposit exhibit well-marked striations upon their flaked surfaces.



FIGS. 3 and 3A.—Late Acheulean hand-axe from glacial gravel, Cromer.

In order to give students of prehistoric archæology an opportunity of forming a judgment as to the kind of implements found during my recent researches, I give here illustrations (Figs. 1 and 1A and 2) of two specimens of Early Chellean implements from the foreshore site at Cromer. Both of these are of the "black-leaded" variety. The majority of the Early Chellean "hand-axes" (of which I have now upwards of 40 examples), referable to the base of the Cromer Forest Bed deposits, are of the batiform type—having one face more or less flat, and formed usually by a single flake-removing blow, while the other face is convex and exhibits numerous flake-scars. This peculiarity applies both to the ochreous and to the "black-leaded" specimens. I illustrate in Fig. 2 an implement of the batiform type, while in Figs. 1 and 1A are shown two views of a specimen of a much rarer form, which approximates to the platessiform type, and is more or less rhomboidal in section.

[1] Moir, J. Reid. "The Great Flint Implements of Cromer, Norfolk." (W. E. Harrison, Ancient House Press, Ipswich.)

It is of much interest to note that Early Chellean implements, which correspond in all their main features to those found at Cromer, occur in the lower portion of the well-known palæolithic gravel at Warren Hill in north-west Suffolk. The specimens in this deposit, which show marked signs of transport, exhibit a different coloration and general appearance from the Cromer hand-axes, due to the differing conditions to which they have been subjected. The last-named specimens show a peculiar wearing down of their ridges, and outstanding portions, which is not usually found, so far as my knowledge extends, associated with river-gravel implements. With the hand-axes of the Cromer Forest Bed has been found a large series of scrapers of various kinds, and also many flakes—which, however, cannot be described in this communication, owing to limitations of space.

In the glacial gravel capping the cliff at Cromer, and at East Runton, have now been found two implements of Late Acheulean type. Both of these have been discovered by Mr. Guy Maynard, who on several occasions has accompanied me to Cromer. One of the specimens mentioned, a small and typical hand-axe, exhibiting "basket-work" patination, is illustrated in Figs. 3 and 3A (the surface marked T in Fig. 3A is of thermal origin). When the Cromer research is completed, I hope to publish a full and detailed account of the whole of the results obtained.

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The Theory of Hearing.

I SHOULD like to express my agreement with the letters which Sir Richard Paget and Mr. Wilkinson have written (NATURE, July 19, p. 87) under the above heading. It seems to me that even if Prof. Scripture is right in stating that the movements of the vocal chords cannot be analysed, he is not justified in concluding that the aerial vibrations thus set up are not analysable either. There is, I believe, massailable evidence that such a conclusion would be wrong; because all workers in this field from Helmholtz and McKendrick to Miller and Bevier are in agreement as to the success of such analysis. Their analyses differ somewhat, it is true, but individual and national peculiarities in vowel production probably account for these. With regard to the piano experiments, I fear that Prof. Scripture (NATURE, August 9, p. 194) has not appreciated the fact that his criticism of Sir R. A. S. Paget and Mr. Wilkinson, namely, that "what a person hears is chiefly what he expects to hear," applies with equal force to himself.

Returning to Prof. Scripture's main argument for one moment, I should like to put a number of questions to him. (1) What experimental proof has he for the statement that the equation for a single laryngeal puff is $y = a.e^{-\epsilon t}$? (2) Are not the variations of pitch of the voice limited in most individuals to about two octaves? (3) Are the variations in pitch in speech more rapid than two octaves per second? If (2) and (3) are answerable in the affirmative, then the results of my experiments quoted in my last letter to NATURE would apply, namely, that a relatively small group of resonators will be affected at any one moment, and that the group thus affected will shift as a whole according to the change in pitch of the voice.

Lastly, may I give some notes on the important point raised by Mr. Wilkinson, namely, as to the damping coefficient of the ear resonators. To commence with, I should like to point out that two additional factors are involved in any attempt to determine the physiological behaviour of the ear, namely, (1) the least amplitude of vibration of resonators of different pitch which will just cause noticeable stimulation of the corresponding hair cells, and (2) the least perceptible difference between the amplitudes of the resonators set up by two immediately successive tones—in other words, the absolute and difference thresholds respectively. It is not difficult to see the importance of these two factors. Two examples will suffice: (1) The ability of an individual to judge if two tones of the same pitch have the same intensity is determined not alone by the difference in amplitude of vibration which these set up in the ear resonators, but also on the ability of the hair cells to perceive the difference. (2) The time taken for silence to follow the cessation of a tone depends not only on the rapidity with which the resonators return to rest, but also on the amplitude of the vibrations to which the hair cells cease to respond.

There are thus three quantities to be determined, the two thresholds mentioned above and the damping coefficient of the resonators. By methods to be described fully elsewhere, I have obtained the following provisional values for these quantities:

The absolute threshold is reached when the amplitude of swing of the resonators falls below 5·8 per cent. of the previous steady value.

The difference threshold is reached when the amplitude of swing of the resonators falls or rises by more than 2·6 per cent. of the previous steady value.

From the damping coefficients the following tuning and persistence coefficients were obtained:

Tone.	Tuning Coefficient.	Persistence Coefficient.
	Per Cent.	
128	9·0	6·5
256	7·5	8·0
512	6·3	9·5
1024	5·4	11·0

The tuning coefficients are the percentage difference of frequency between that pitch which is in tune with a given resonator and that which will produce one-tenth the amplitude of swing which the intune one would have done.

The persistence coefficient is the number of complete swings which would occur in the time taken for the amplitude of the resonator to fall to one-tenth its previous value.

From these values it is possible to make a number of calculations, which can then be compared with the results of experiment. For example, one can calculate the difference of pitch necessary for the differentiation of two successive tones or the time taken for silence to follow the cessation of a tone.

Tone.	Calculated just Perceptible Difference of Pitch in Cents.	Calculated Time to reach Silence in Hundredths of a Second.
128	1·5	6·9
256	1·3	4·3
512	1·1	2·5
1024	0·9	1·5

These calculated pitch difference values compare well with experimental ones given in the table below, except with 120 vibrations per sec., at which the calculated value is too beneficial.

Tone.	Observed just Perceptible Difference of Pitch in Cents.	
	Delezenne.	Külpe.
120	6	...
260	...	1·24
500	1·0	...
1000	0·84	...

The values for "the time to reach silence" would permit a shake or trill of the following number of tones per second to be clearly heard.

Tone.	No. of Notes per Second clearly audible.
128	14·5
256	23·0
512	40·0
1024	67·0

Unfortunately, I know of no extended experimental results by which these values can be checked. They fit, however, Helmholtz's statement that a shake or trill of 10 notes per second, which is clear for tones above about 110 vibrations per sec., ceases to be clear below that pitch.

With regard to the least and greatest differences of pitch between two tones for audible beats, the calculated and observed values appear to fit well. Perhaps I may finish this letter by asking Mr. Wilkinson if these values also fit in with the data at his disposal.

Lastly, being a physiologist, I cannot agree with Prof. Scripture's suggestion (p. 194) that the resonance theory is unthinkable to those who work with delicate human tissues. Neither can I take seriously his proposal that the resonance theory be abandoned and his own substituted. The resonance theory has so far passed every test that I have put to it. Why then think of abandoning it? If I had any doubts lurking in my mind concerning it, or if I thought that it had need to fear rivals, I might, with the editor's permission, tell Prof. Scripture exactly what I think of his theory. But, as neither is the case, I feel there is no need for me to do this. If I have a regret, it is that Prof. Scripture is not as familiar with resonators as he apparently is with delicate human tissues.

H. HARTRIDGE.

King's College, Cambridge.

On Early Sexual Maturity in the Molluscs, *Syndosmya alba* and *Cardium fasciatum*.

IN November 1920, good numbers of the mollusc *Syndosmya alba* round about 15 mm. in length and sexually mature were taken by dredging in the Black Deep near the Edinburgh Lightship. The occurrence of this bivalve, practically on the spot where munitions had recently been dumped, is a matter of much interest, so that observations on the life-history of this form are worth recording. It was suspected at the time that the specimens taken in 1920 were at least six months old, as estimated from material obtained in the sea experimentally, but recently the present writer had the good fortune to obtain a good fall of young ones of this species in a cage which had been in the sea in the River Blackwater in the Thames Estuary area about eight months, *i.e.* from October 22, 1923, to June 7, 1924. In this case the valves of *Pecten maximus* and *Ostrea edulis* were strung on tarred rope in pairs, so that pairs of the shells were in the same relative position as in life. In the cavity of these shells a certain amount of mud accumulated and in this nidus young Syndosmya settled at some time later and grew to a size varying from 6·5 to 12·0 mm. in length. Individuals about 8·0 mm. in length were found to be approaching sexual maturity.

An artificial fertilisation was made on June 8, 1924, from a ripe male and female 11·5 and 12·0 mm. long respectively, after the eggs had matured in the sea-water for one hour. It was found that in less than five minutes the ripe egg threw out a large vesicular transparent membrane; in about three hours embryos in two to seven celled stages occurred, and in twenty-four hours a ciliated larva; in less than forty-eight hours a fully formed trochosphere developed with a fine apical tuft resembling the similar stage in the Gastropod, Patella. In a similar experiment male and female *Cardium fasciatum* 8·3 and 8·5 mm. long were obtained sexually mature, and yielded a thin-shelled veliger in the double egg-case in less than forty-eight hours, and a good shelled larva in four days.

Similar material of Syndosmya and Cardium had been obtained in previous years in a period of three to four summer months, but in circumstances where age determination was less certain.

It is a very difficult matter to grow animals of this kind in the sea and be absolutely certain of their age; in the experiment quoted above there is a faint possibility that some of the Syndosmya may have been washed between the shells, although the chance is very remote, as the cage in which the shells were fixed was specially raised 3 feet from the bed of the sea. An experiment has been devised, however, to obtain more information. A point of interest about the early trochosphere of Syndosmya is that it changes its direction of revolution in the egg-capsule in a rhythmical manner which apparently varies with the physical conditions.

At the same time as Syndosmya and Cardium were growing to sexual maturity, European oysters (*O. edulis*) settled in a similar situation and grew to a size of more than one inch long by one inch deep, while Portuguese oysters (*O. angulata*) grew to as much as 32·6 mm. long by 44·0 mm. deep, although the young oysters of both kinds were mostly less than half an inch long at the end of last year's growth. Thus, although the sexually mature Syndosmya and Cardium cannot be more than eight months old, there is good reason to infer that they may be much younger, especially as the shells showed mostly no indication of a winter ring. It is probable that both these forms mature in summer in about three or four months.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, July 24.

The Reported Transmutation of Mercury into Gold.

IN your account of the reported discovery, by Prof. Miethe, of the transmutation of mercury into gold (NATURE, Aug. 9, p. 197) by the prolonged action of a high-tension electric current upon it, you seem to consider only one way, and that not the more obvious way, of effecting such a transmutation, namely, by striking out a hydrogen ion from the nucleus by some powerful method of disruption. There is another method of effecting such a change, namely, by attaching an electron to the mercury nucleus. Indeed, for some time before Prof. Miethe's announcement it has been clear to me that, by passing a sufficiently high tension discharge through mercury vapour, not merely that such a transmutation might occur, but that it was inevitable, unless our present views of atomic structure are radically at fault.

For consider the collision of high-speed electrons with mercury atoms. A small proportion of these

electrons must be directed upon the nucleus. If they possess sufficient energy to penetrate the external levels of electrons in the mercury atom, they must reach the positively charged nucleus and be captured by it. Since the loss of an electron (as a β-ray) by the nucleus of an element in the radioactive disintegration of an element results in the atomic number of the element in question being increased by one, the gain of an electron by an atomic nucleus must result in the diminution of the atomic number by one. This is quite general. In the case of an isotope of mercury of atomic number 80, the product will be an isotope of gold of atomic number 79. Upon existing knowledge it is simply a question of (1) the potential sufficient to drive the electron through the outer levels of electrons surrounding the mercury nucleus until it comes within the sphere of attraction of the powerfully charged nucleus; (2) whether the exceedingly small fraction of direct collisions with the nucleus that is to be anticipated will be sufficient to enable the gold produced to be detected.

As regards the first, it may be expected that the repulsion of the external shell of mercury electrons will diminish rather than prevent altogether the chance of the radiant electron reaching the nucleus; for once the shell is penetrated, the resultant force on the radiant electron must be on the average an attraction. Hence I had arrived at the conclusion that, not the transmutation, but the chemical detection of the gold produced, would probably be the more formidable experimental difficulty.

Of course, I need express no opinion on the correctness of the experimental results recorded, which naturally will have to be very rigorously confirmed by further work. I merely wish to point out that no atomic disruption is necessarily involved, and that, so far from conflicting with existing knowledge, the result in a sense follows naturally from it, the only question being one of the sensitiveness of the experimental methods of detecting gold.

Frederick Soddy.

Oxford, August 9.

The Transmission of a New Plant Virus Disease by Insects.

In a paper read to the Imperial Botanical Conference held in London this year, I have described a variegated condition of a number of Graminaceous plants, characterised by chlorosis of the leaves in narrow broken stripes parallel to the veins and a reduction in the power of growth of the plant. In maize it has been recognised for many years as a factor limiting production in the coastal and midland areas of Natal, and was described as long ago as 1901 by Fuller (First Report, Government Entomologist, Natal). Similar conditions are found in sugar cane and a number of other grasses.

I have given evidence in the paper mentioned for the belief that this variegated condition is a disease of a type similar to the now well-known mosaic disease of sugar cane, maize and other grasses, but is not identical with it. These conclusions were at that time based upon general observations and lacked evidence of experimental transfer. Recent work upon insect-transmission of the disease occurring in maize affords confirmation of the conclusions originally reached.

In a series of experiments I have been able to demonstrate the ability of the adults of a Jassid leaf-hopper, an undescribed species of the genus Balclutha, to produce the disease in healthy maize plants when transferred to them from diseased plants. Hoppers taken from healthy plants have failed to produce the disease. All plants have been protected from outside infection for the whole period of the experiment, and no control plants have developed the disease. The role of *Aphis Maidis* Fitch as the vector of mosaic disease between sugar cane, maize, and certain grasses has been established by several workers, and has been confirmed by me under South African conditions. All attempts to secure infections of this new disease through the agency of *A. Maidis* have failed.

The experiments referred to have been carried out with leaf-hoppers collected in diseased maize fields. A proportion only of such individuals are capable of producing the disease, although the maize may be almost universally infected. No individuals, however, which have been once proved to be vectors, have failed to transmit the disease to all plants to which they have been subsequently moved.

Preliminary attempts to secure transmission of the disease from maize to sugar cane and grasses have not succeeded. It must, therefore, remain in doubt whether it is a single disease which occurs in the different hosts, although field observations and similarity of symptoms would point to this conclusion.

H. H. Storey.

The Natal Herbarium,
Durban, July 8.

Isotopes of Mercury and Bismuth and the Satellites of their Spectral Lines.

In his letter to Nature (May 31, p. 781), Prof. Runge criticised the result of measurements on the satellites of mercury and bismuth lines in connexion with the isotopes, which I and my co-workers have communicated to Nature (March 29, p. 459), as not convincing. It gives me much pleasure that our note has attracted the attention of such an eminent spectroscopist and mathematician as Prof. Runge. The aim of that note was to show that the wave-length differences $\delta\lambda$, according to our formula, which involves the masses of different isotopes, are found among the satellites of mercury and bismuth lines. Prof. Runge discarded *i* and *j*, and took wave-length differences of observed satellites at random, which is contrary to our view, as regards the selection. The example given by Prof. Runge seems to me to be *lauter Zahlenspielerei*.

Perhaps the lines we have cited have too many satellites to incur a criticism; there are, however, many lines with a small number of satellites, and in which the number of selections is but limited. I can cite many such examples, but as the result obtained on satellites of twenty principal lines of mercury has already appeared in the *Japanese Journal of Physics*, vol. ii., pp. 121-162, the publication of which was much retarded by the disastrous earthquake, I consider it needless to occupy the columns of Nature with the details. We have obtained more than 130 coincidences with our formula, within the limits of errors of observation, in mercury lines from the yellow to the ultra-violet region, so that the probability of its validity is very great, and cannot be considered as due to mere chance. The report on bismuth lines will shortly appear in the above Journal.

If we completely separate the isotopes, investigate the difference between the satellites and confirm our result, the proof will no more be open to criticism. Only partial separation of isotopes is at present possible, but even this will help us to study the intensity difference of the satellites, by which the present question can be in some degree settled more directly than by the arrangement of the satellites.

H. Nagaoka.

Institute of Physical and Chemical Research,
Komagome, Tokyo, July 2.

The Cooling Power of the Air in Trains, Trams, and Buses.

By LEONARD HILL, F.R.S., with the co-operation of M. BRAD (from the National Institute for Medical Research).

THE body resembles a motor-car engine in that it is producing heat by the combustion, not of petrol but of food, and, just as the car has a radiator, so has the body—namely, the skin—in order to lose heat and keep at body temperature, that is, the temperature at which the living tissues have to live. During muscular exercise, about four times as much heat is produced as work, and when hard exercise is taken, such as climbing, the heat production of the body may be five times as great as when sitting at rest. The loss of heat is controlled, just as the production, by bodily mechanisms. To accelerate heat loss, the skin flushes with blood and perspires; clothes are thrown off and the body fanned. Over-warm stagnant atmospheres and over-clothing check the production of body heat and lead to disinclination to exertion, loss of appetite, and, in time, to debility. Cool surroundings and light clothing, on the other hand, increase the production of body heat, tone up the body, stimulate appetite, impel to activity, and generally improve health.

The ordinary thermometer indicates the average effect of the temperature of the surroundings on itself. Unlike the body it does not produce heat. If a fan is set to blow about the air of the room in which it hangs, its reading does not alter. The body, on the other hand, is very effectually cooled by the fan. The thermometer is, then, an untrustworthy guide to ventilation. The kata-thermometer has been introduced to remedy its defects. This instrument has a bulb which is warmed to just above the average temperature of the human skin, and its rate of cooling is measured during a drop of five degrees, namely, between 100° and 95° F.

In this way the power of the air in any locality to cool a surface approximately at skin temperature can be measured. The measurements are made in millicalories per sq. cm. per second. The bulb of the instrument is roughly the size of the end joint of the thumb. The big masses of the body are cooled less rapidly, having a smaller surface in proportion to their bulk. The kata-thermometer does not, then, actually measure the cooling effect of the air on the human body, but is a valuable indicator of comfortable and healthy conditions.

In rooms kept fresh and warm enough for sedentary work, the cooling power is found to be about 6. In stuffy rooms 4, or even less; in rooms rather cold for comfort, 8. Out-of-doors, where the wind blows, cooling powers are higher; for example, 10 on a genial summer day, 20 on mild winter days, 40 on cold winter days. The open-air worker is stimulated by much higher cooling powers than the sedentary workers, even when the temperature is the same indoors and out, owing to the movement of the air out-of-doors.

As we have said, an adequate cooling power of the air is required to keep "the fire of life" from burning too feebly, to tone up the muscles, invigorate the nervous system, and make keen the appetite and efficient the digestion and action of the bowels.

It has been shown that exposure of the naked body of children to sun and open air, with of course wise prevention of over-cooling, has a wonderful curative effect on states of debility, rickets, and surgical tuberculosis. An adequate increase of cooling power puts up the basal metabolism, that is the heat production of the resting body, even 50–100 per cent. We know that thousands of clerks, shop assistants, factory hands taken from lives spent in monotonous over-warm places were changed from feebly developed, nervous, dyspeptic men into strong healthy soldiers by training in open-air exercises during the Great War.

Severely exposed to weather in the trenches, these men suffered far less from catarrhal diseases than those who continued in employment in cities. The soldiers caught "colds" not in the trenches, but when on leave and infected by close contact with "carriers" in the crowded places of cities. Americans overheat their houses and suffer from catarrhal complaints. The death-rate from pneumonia in U.S.A. has not gone down with that progress in medicine which has notably lowered the death-rates from most other diseases. While exposure to the open air, with the invigorating effect of cool winds and daily exercise, is necessary for all who want to attain full health and enjoyment of life, people, mistakenly attributing the origin of catarrhal disease to exposure to cold, have in the past demanded the over-heating of railway carriages and shutting of windows and the closing in of the roof-seats of trams. Suggestions recently have been put forward for the heating of trams, and the roofing over of the outside seats of buses has been discussed. There have been many who have wished, and some more courageous who have struggled to secure the opening of windows in trains, and these last have been ridiculed in the Press as "open-air fiends" by journalists who are habituated to the stuffy over-warm newspaper offices of Fleet Street. Soldiers, however, hardened in the trenches, on returning from the Great War demanded greater opening of windows in trains, and this habit of open windows has of late become more general.

People are beginning to realise that catarrhal infections are spread by wrong conditions of the atmosphere indoors, and by repeated massive doses of microbes inhaled from "carriers" who sneeze and cough in close crowded places. Even comic artists and artists of patent medicine advertisements now try to illustrate the happenings of such infection. As tube trains and trams are closed up more than buses, and as people continue to dispute over the opening of windows in steam trains, it seemed worth while measuring the cooling powers of the air by means of the kata-thermometer in such trains with windows shut or open, and in tube trains, trams, and buses, comparing in these last the inside and outside. The temperature of the air was also taken and the velocity of the air movement calculated from a formula which allows the kata-thermometer to be used as a very sensitive anemometer. The following are the average results of observations made when conditions were best in the non-crowded

parts of the day, in mild or cool weather, during September and October of 1923.

	Dry Kata-thermometer Cooling Power. Millicals. per sq. cm. per sec.	Temperature. °F.	Velocity of Air Movement. Feet per min.
Central London Tube.			
In moving train . .	6-10	70-72	54-222
Hampstead Tube.			
In moving train . .	5-9	66-75	55-270
On platforms . .	7-16	63-72	168-425
North London Electric.			
In moving train . .	4-8	60-75	12-83
Bakerloo.			
In moving train . .	5-6	73-75	49-59
S.R., L.N.E.R., and L.M.S.R.			
Steam Trains—			
In moving train :			
Windows closed .	5-9	52-70	20-35
Windows open and facing engine .	9-19	48-66	125-320
Windows open and back to engine	7-12	50-67	49-96
Trams, L.C.C.			
Moving	4-8	67-72	12-126
Buses.			
Moving, inside . .	9-20	57-61	71-541
„ outside . .	10-31	50-60	232-1043

The standard dry kata-thermometer cooling power suitable for sedentary work in ordinary clothing is 6. Lower cooling powers produce stuffy sensations and require less clothing. If people used foot-warmers, and in some cases wore more clothing when at sedentary work, they could easily bear windows open and a cooling power of 8, or even 10, and have the great advantage of breathing cooler, cleaner air. A sanatorium ward is best kept at such a cooling power as 10. In travelling to and fro wearing outdoor wraps, people can, with advantage, be stimulated by wind giving much higher cooling powers than 6. The bus stands pre-eminent in this respect, and healthy people who enjoy a blow in the fresh air and recognise the good effect of this on health rejoice in the open roof-seats of the bus. The cooling powers outside the bus were 10-31 against 4-8 in the tram. It is regrettable that the roof-seats of trams were ever closed. Those of buses certainly should not be. A removable rain screen open at the sides is all that is wanted in bad weather.

Tubes and steam trains with closed windows and trams are relatively stuffy places, cooling powers 4-10, compared to outside of buses, cooling powers 10-31, and steam trains with windows open, cooling powers 9-19. The seat facing the engine in the steam train with window open is recognised to be much cooler than that with the back to the engine; by how much on cool autumnal days the figures show, 7-12 against 9-19. The cooling power at a seat facing the engine can be doubled or even trebled by opening the window.

The figures also show that movement of air and not temperature is the chief factor at work.

In steam trains with windows open and on the outside of buses, massive infection with the microbes from "carriers" is impossible.

The British Association at Toronto.

(From our Correspondent.)

Toronto, August 10.

OPPRESSIVELY hot weather during the first half of this year's meeting of the British Association at the University of Toronto has made the excursions into the neighbouring countryside particularly popular among the 2600 men of science and citizens who have enrolled as members to the present date. Thunder showers at night have, however, cooled down the hot lecture rooms and rendezvous periodically, and have thus made meetings possible without interfering with communication in the daytime between the score of University buildings utilised for them. The overseas party, numbering 573, was fêted on the way through eastern cities, and most members of it have been given hospitality in private houses in Toronto. Others, with more than three hundred men of science from the United States, are quartered in University residences. Hart House, which is the social and recreational centre of the male University life, has been thrown open to men and women, and the dining-room has been extended to seat six hundred. The Toronto Board of Trade has been responsible for the enrolment of more than one thousand citizens, and the balance of local members is drawn from adjacent towns, many coming in every day for the meeting, so that the hotels are full.

The Convocation Hall of the University of Toronto, seating eighteen hundred people, was packed on Wednesday night, August 6, when Sir Ernest Rutherford vacated the president's chair for his successor, Sir David Bruce. While lightning flashed across black skies outside the building, Sir Robert Falconer, president of the University, welcomed the visitors and said that Canada needed the stimulus which this visit of the British Association would afford. Prof. J. C. Fields, president of the Royal Canadian Institute, also expressed the welcome of the hosts in the name of the Institute. Prof. J. C. McLennan, chairman of the general and executive committees, moved the vote of thanks to Sir David Bruce for his address.

Representative overseas delegates were received by Cabinet ministers in the Parliament Buildings on Wednesday afternoon, August 6, when the Hon. George H. Henry, senior Government minister, extended the hospitality of the Province to the Association. Sir Ernest Rutherford replied on behalf of the delegates. On the evening of August 7, a reception was given by the trustees and directors of the Royal Ontario Museum of Archeology, and was attended by two thousand people, including nearly all the members of the overseas party. The guests were received by Mr. J. B. O'Brian, the Hon. Charles McCrea, the Hon. Dr. Cody, and Mrs. Cody. Many social events have been held, including luncheons, teas, dinners, etc., arranged by

local societies and numerous private individuals. Saturday, August 9, was devoted to excursions, of which those to the Niagara Falls district were most popular.

The popular and citizens' lectures have been thronged. On Thursday, Sir Henry Fowler lectured on metallurgy and its influence on social life; on Friday, Mr. Julian Huxley on control of growth; and on Saturday, Prof. Eddington on relativity. The first children's lecture by Sir William Bragg, on Friday, was most enthusiastically received. Popular meetings and lectures are being broadcast and picked up all over America. The scientific sessions are attracting wide attention, Toronto newspapers devoting several pages to them daily, while the Canadian press generally is giving prominence to them, also the leading United States journals. The meeting is in every way a successful one, and the attendance is satisfactory. Prof. J. L. Myres, general secretary of the Association, praised the local arrangements when speaking at a dinner tendered to visiting Freemasons by the University Lodge on Saturday.

A party of geologists is making a tour in northern Ontario on August 14-19; one of botanists is visiting Temagami Lake district on August 14-18; and one of agriculturists is to visit the Ontario Agricultural College, Guelph, on August 15. Three hundred members are taking part in the general excursions to the Pacific coast, leaving on Sunday, August 17, arriving at Vancouver on August 25, and returning to Toronto on September 3. There will be meetings at Saskatoon, Edmonton, and Vancouver, and halts at all points of scientific or scenic interest. The party goes out by the Canadian National Railway and returns by the Canadian Pacific. Many visitors from Great Britain are making lecture tours in the United States before returning home.

Prof. Horace Lamb has been elected by the General Committee president of the Association for the meeting next year in Southampton.

At a special convocation of the University of Toronto on Wednesday night, August 13, the degree of Doctor of Science, *honoris causa*, is to be conferred on Sir David Bruce, Sir Ernest Rutherford, Sir John Russell, and Sir Charles Parsons.

The three remaining addresses of presidents of Sections were delivered on Monday, August 11, and are described below.

Analysis of Crystal Structure by X-rays.

In his address to Section A (Mathematics and Physics), the president, Sir William H. Bragg, gives a very useful summary of the present position and the limitations of the new methods of analysing crystal structure by means of X-rays. He first discriminates three distinct stages, namely, (1) the measurement of the angle at which X-rays of a given wave-length are reflected by a set of identically similar planes within the crystal; (2) the use of the angular measurement to find the spacing of the set of planes, and hence the linear dimensions of the crystal-unit cell; and (3) the combination of the spacings of three different sets of planes to afford the volume of the unit cell. From these fundamental determinations, and a knowledge of the specific gravity of the crystal, the number of atoms of various kinds contained in the cell are found; and, as the proportion of the various kinds is the same as in the molecule, the number of molecules, one, two, three, four, or rarely more, comprised in the cell is afforded. By the repetition of this cell, in accordance with the degree of symmetry developed, without any new features, the crystal is built up.

The final aim of the X-ray analysis is to determine the arrangement of the molecules, and of the atoms comprising the latter, in the crystal-unit cell. Sir William Bragg emphasises, however, that the only measurement which the X-rays make directly is that of the distance separating any atom in the crystal from any other nearest adjacent one which is of like kind and condition of environment, from which the outlook would be exactly the same and with similar orientation. Any other measurement of distance is an indirect one made with the aid of some additional crystallographic (physical or chemical) reasoning. It is not possible to measure directly by X-rays the distance between two atom-centres within the same cell. For example, in the two-molecule crystal-unit of naphthalene we cannot measure the distance separating one carbon atom from another in the same dimolecular cell, even those of the two separate molecules (which are differently orientated); the measurements afforded are those between any atom and its nearest neighbours exactly like itself in the three principal (axial) directions; that is, belonging to different adjacent cells, these distances being the lengths of the edges of the unit cell. Fresh considerations, such as the knowledge that naphthalene has a centre of symmetry, are required even to define the distance between the centres of the two molecules in the cell; or as in the case of rock-salt, the knowledge of the full crystal symmetry is needed to give us the distance between adjacent sodium and chlorine atoms, the X-ray measurements only affording that between any two sodium atoms, or any two chlorine atoms. Hence, the work of the crystallographer is absolutely necessary, especially as to symmetry and the polarity due to lack of it, exterior angles and the crystal elements derived therefrom, and the physical properties, if the measurements by X-rays are to have their full value. It is a great gain that this has now been so clearly stated.

Sir William Bragg then shows how the X-ray work combined with all these other available sources of information, is enabling us to fix on the particular one of the 230 modes of interior arrangement of atoms possible to crystals, which occurs in the crystal under investigation, and incidentally shows that all cases investigated have conformed to one or other of these modes. The lesser problem of allocating the crystal to its proper class among the 32 differently symmetrical classes of crystals has consequently been solved in most cases with comparative ease. But again, it must be emphasised that the X-ray measurements alone do not permit of so satisfactory a result being attained.

Sir William Bragg also makes it clear that the alarm exhibited, when the first X-ray results were published, as to the apparent disappearance of the molecule, was a "mare's nest." There is nothing whatever to suggest a complete disruption of the alliances within the molecule so successfully studied and brought to light by

the chemist, and it is now certain that the conclusions of chemistry are valid for and carried into the solid crystal as well as into the liquid, for the chemical molecule takes its place as such in the crystal structure with very little change.

It is thus in the combination of the results of the X-ray analyst with those of the crystallographer, the physicist, and the chemist that future progress in the elucidation of the structure of the fully developed solid —the crystal—must be looked for. In thus unambiguously setting forth the limitations of the new method by use of X-rays, and the absolute need of collaboration in the study of crystals and solids in general, the president of the Section has rendered a special service.

LIFE-CONTROL.

PROF. F. W. GAMBLE'S presidential address in the Section of Zoology is an example of strong, matured thinking. It is futuristic rather than a retrospect of the things done and thought in the biology of the immediate past. Seizing on the present methods of experimental embryology it sees in them something pregnant with results that must profoundly modify future biological speculation. Can those results be seen, even if only in a vision, and what may be their nature? The address is an innovation that must be welcome to members of the Section.

More and more biology pries into the nature of the process that makes a specific organism from an apparently undifferentiated egg. This process, whatever it is, must be potential in the egg, becoming kinetic from the moment when the spermatozoon—the "Orpheus that visits the cold Eurydice," the "winged key that unlocks the imprisoned one"—passes through the bounding membrane and sets up the releasing transformation that results in embryonic development. The process is not in the outer environment which, while nurturing in precisely the same way the eggs of a hen and a duck, yet makes of the one a chick and of the other a duckling. Past conceptions of the nature of the developmental process were curiously naïf; they conceived of the ovum about to divide as an assemblage of parts, jumbled together in some way, a chaos of parts but nevertheless parts that were preformed and extended. Something called the "organisation" was supposed to usher the parts into place, laying down, in ordered fashion, the organ-systems, organs and tissues of the embryonic body. Then came the study of aberrations of development to perplex and obscure this simple conception. The organisation existed in the undivided ovum, leading to the segmentation of the latter, so that a number of blastomeres came into existence, each normally giving rise to a different part of the embryonic (and so also the adult) body. Yet the experimentalist could literally shatter the organisation to bits and find that each bit became another organisation (for each blastomere could regenerate a whole embryo). He could divide it in an infinity of parts without impairing it. Thus the egg and its parts, or the embryo and its parts, were autonomous and capable of regulation. The study of the nature of the organisation became the study of life itself—and it became (to many minds) a problem incapable of solution on the classic physico-chemical hypothesis of the nineteenth century. To an increasing number of biologists life becomes an ultimate natural category sharing, with matter and energy, our conception of the universe.

Now among the pregnant methods of present-day embryology there is this: it has become possible to study the mode of operation of the organisation in the developing egg and in the adult, multicellular organism (and it is essentially the same in each of these cases). In the egg the organisation radiates from a focus: in the adult it radiates from an apex or head. The components of the radiation are from head to posterior body regions along the longitudinal nervous axis; from nervous axis to right and left in bilaterally symmetrical animals, and from nervous axis to the ventral regions (in vertebrates), or to posterior regions (in an insect). Along each of these radiative paths the intensity of the control exercised by the focal region diminishes with the distance; there are metabolic gradients and these are demonstrable by various chemical methods. The gradient expresses the degree of positive control which the head region holds upon the functioning of the bodily organs and tissues. This apical control is one of quickening, urging, and directing of physiological activities. The possibility of control is, so to speak, vested in the head, or apical region, which reaches out into the outer world by its distance receptors, ever seeking to increase its environment. Environment and organism, reciprocal activities, are one—that which we call ordered life.

Yet, because the intensity of quickening and directing diminishes with the distance from the focus, there can be physiological isolation of a bodily part—limited, of course, and it may be transient. In the absence of control the part rests—it may be periodically. While it rests its potential rises and when it again comes under the focal control its functioning quickens. So in reserve organic material, two kidneys or testes, one of which may be enough for normal bodily activity, there is periodic alternation of rest and activity. But in the rest consequent on the removal of control there is still the urge of life, for the potential of the part increases. Should the focal control not be re-established what happens? There is always the tendency to individualisation, and the organism may segment and multiply—thus in a dividing Planarian worm the metabolic gradient shows a peak at the region where segmentation will occur. So also we seem to be able to interpret the formation of malignant tissue. Removed from the control of the cerebrum, which blends the activity of the part with those of all other parts of the body the intensity of life may still increase during this resting phase. Then connective tissue, or mammary gland, or testis attains higher metabolic potential, and still drawing on the circulating nutritive materials it endeavours to function; it cannot do so in normal fashion because it is undirected, and it proceeds to proliferate, passing into the cancerous condition.

And here we see, stated as an inference from experimental results, something of the terribleness of life—that which is sinister because it is disorderly. There is a "submerged recessive life" charged with activity, ever seeking to expand or grow. Specific organisations deploy this in ordered morphological and functional varieties. Given this "grace of organic regulation" and the life that incessantly insinuates itself into inert

matter assumes the hierarchical forms that evolution shows us. Without it and we see in life something inchoate but, in a way, fœtid and malignant: something suggested to us by the cancerous tumour or the luxuriantly living and rotting tropical jungle. Here, and in the backwaters of organic evolution—the "living fossils" that are poised between extinction and stability, or the primitive and unprogressive human societies—we see the life of the future: the inextinguishable vital impulse that waits on the ordering control that will lead to its deployment in new organic forms.

Problems of Crop Production.

In his address as president of Section M (Agriculture), Sir John Russell reviews the present position of agricultural research as compared with that occupied when the British Association visited Toronto in 1884. Up to that time the man of science had been occupied with the problem of how to feed the plant. Agricultural science was regarded as simply a branch of chemistry; but, during the last forty years, many new problems involving the biological sciences had presented themselves for solution. These problems are related to the growth of the plant as affected by inherent and environmental variations. Sir John Russell points out that, whereas the great discovery during the early period was that the plant could be fed by "artificial" substances, the most pregnant discovery of the second period was that the plant is plastic; by methods which are under scientific control it can be modified in desired directions, and thus be induced to give results that mere feeding cannot accomplish. Following the pioneer labours of Bateson, astonishing practica results have been reached by such workers a Biffen in England, Nielsen Ehle in Sweden, an the Howards in India. But the science of genetic is only on the threshold of what it may ye accomplish.

Sir John Russell then goes on to review, in detail recent advances that have been made in the science with which he is particularly concerned at Rothamsted He emphasises the pressing need for subjecting the grea mass of material that has now accumulated to statistica analysis. In regard to the numerous empirical dat from "field" experiments, Sir John Russell is o opinion that no advance can be expected until som fresh opening is discovered by scientific workers. Wit regard to the more rigid data accumulated by labora tory workers, the view is expressed that the greates field for discovery lies in the direction of linking u plant nutrition studies with those of the soil solution the latter being explored in the light of the physico chemical interactions between soil and soil water. O the more general issues Sir John Russell is insistent o the need for fuller co-operation between all classes o scientific workers—for team work which shall includ workers of all nations. But when all is said and done the great expenditure of time and money now bein incurred in agricultural research can only be justifie by abandoning the view that the economic end alon is worthy of the effort. The address closes with a eloquent appeal for a wider vision, for an effort t upraise country life by revealing to the countryma "something of the wonder and mystery of the ope spaces in which he dwells."

Obituary.

Prof. J. Wertheimer.

THE death, on August 9, of Prof. Julius Wertheimer, at sixty-four years of age, deprives both science and technical education of a most active and stimulating worker. Since 1890, when he was appointed principal of the Merchant Venturers' Technical College, Bristol, he took a leading part in promoting scientific and technological instruction in the city, with the result that, when the University of Bristol was established in 1909, the faculty of engineering was instituted at the College, with Prof. Wertheimer as dean of the faculty and also professor of applied chemistry.

Prof. Wertheimer was educated at University College, Liverpool, and Owens College, Manchester, and was headmaster of the Leeds School of Science and Technology from 1887 to 1890. He was a fellow of the Institute of Chemistry, the Chemical Societies of London and Berlin, and the Physical Society of London. He was for ten years hon. secretary of the Association of Technical Institutions, and was the author of textbooks of practical chemistry and of scientific and educational articles in various journals, including Nature. His long experience and wide knowledge of all matters relating to technological education at home and abroad made him a very valuable member of many committees. He served on the Council and Senate of the University of Bristol, the Teachers Registration Council, the Education Committees of the Gloucestershire County Council, the Bristol City Council, the British Science Guild, and other bodies In recognition of his services to science and educatio the degree of doctor of science, *honoris causa*, was con ferred upon Prof. Wertheimer by the University o Bristol in 1911. He also received the honour o Officier d'Académie de France in 1906.

Miss Katherine A. Burke.

By the death of Miss Katherine A. Burke, University College, London, has lost an excellent teacher who was untiring in her devotion to the academic, social, and athletic life of the college. Graduating at Birkbeck College, Miss Burke began her career at University College, in 1898, as a research assistant of the late Sir William Ramsay, and she took a share in the research emanating from the chemical laboratory at about this time. Later, she was appointed to the chemical staff, and was the first woman teacher directly concerned with the teaching of the undergraduates of the college. Miss Burke's original work included research on thorianite, the oxides of chlorine, the Joule-Thomson effect, the chemical dynamics of the alkyl iodides, and the absorption spectra of alcoholic solutions of nitrates. The paper on chemical dynamics, with Prof. F. G. Donnan (Journ. Chem. Soc., 1904, 555), showed that the order of reactivity of the alkyl iodides varied with the type of chemical reaction investigated, and hence it was not possible to ascribe their reactivity

) a uniform cause, such, for example, as a dissociation f the iodides into ions. A research, published jointly ith Prof. E. C. C. Baly and Miss Effie G. Marsden ournal. Chem. Soc., 1909, 1096), on the absorption pectra of the aqueous alcoholic solutions of nitric acid nd lithium, ammonium, and silver nitrates in relation the ionic theory, afforded strong support for the heory of hydrated ions. It was found that the miting conductivity and the persistence of the absorp- on band of these solutions showed a minimum at hree per cent. of water. During the War, in addition her work in connexion with the Voluntary Aid Detachment, Miss Burke found time to assist in the preparation of synthetic drugs, which were so badly needed at that time.

Towards the end of her life, Miss Burke's activities were absorbed in the social and athletic life of the college, particularly in connexion with the acquisition and organisation of the sports ground for women students at Perivale.

We regret to announce the death of Mr. Charles Leudesdorf, fellow and vice-regent of Pembroke College, Oxford, registrar of the University of Oxford, and author of a number of papers on mathematical subjects, on August 10, at seventy-one years of age.

Current Topics and Events.

There has been brought before the Council of the British Association at the Toronto meeting a special report by the Committee on Zoological Bibliography nd Publication, dealing with the question of undue estriction in the distribution of H.M. Government ublications. The results of the inquiries of this Com- ittee are of general interest to scientific workers, and ay be briefly stated. On applying to the heads of ertain Government Institutions, the Committee was nformed that no restriction had recently been placed n the distribution of publications of the Royal otanic Gardens, Kew, the British Museum (Natural istory), or H.M. Geological Survey. On the other and, it found that public libraries had suffered from considerable cutting down of free or reasonably riced Parliamentary and Stationery Office publica- ons (in respect of which some concession has since een made); that certain British scientific societies f standing are no longer able to obtain Government cientific publications in exchange for their own ublications (though foreign scientific societies are not milarly handicapped); that free reprints to authors f papers published by the Government have almost isappeared; that there has been a cessation of the outine free distribution of agricultural leaflets; and hat review copies of Government publications have een curtailed. These findings are in general agree- ent with the statements made in a leading article n Nature, December 29, 1923 (vol. cxii. p. 925). he Committee considers that no loss would ensue ere review copies to be furnished gratis to editors on pplication, and suggests that the Council of the British Association "might well represent to the Government that the publication of the results of esearch among people likely to appreciate them is no ess important than the making of the researches hemselves, and that to refuse the relatively small dditional expenditure is materially to reduce the enefit of the original much greater expenditure." Bearing in mind the effective methods employed by ther governments in the spread of their scientific chievements, no one is likely to quarrel with this xceedingly modest recommendation.

Scientific men are indebted to Major A. G. Church or raising an important question in Parliament, namely, the assessment for income tax of professional men, more especially men of science, who are remunerated by a fixed salary and are therefore assessed under Schedule E. Professional men whose income is made up of fees, and who are, therefore, assessed under Schedule D, are allowed in the assessment of their incomes to deduct from their earnings expenses ordinarily incurred in the course of their work, including the cost of the renewal of technical works of reference, subscriptions to professional societies, the preparation and publication of memoirs —in fact, all expenditure required to maintain their technical efficiency. Such expenses are not as a rule allowed to those assessed under Schedule E. The Financial Secretary to the Treasury denied, however, the existence of such a distinction and offered to have any particular case investigated, in which further relief was believed to be due, provided the necessary particulars were furnished. The question was, as a matter of fact, brought before the Treasury two or three years ago, when it was intimated that such expenses might, for the purpose of assessment, be deducted from the salary received, when they were incurred in consequence of an express requirement of the employer. If, for example, on the appointment of a science lecturer it was stipulated he should carry out research, or that he should join the technical societies relevant to the subject he taught, or take other steps calculated to maintain his scientific position, the necessary expenses might be deducted in ascertaining his assessable income. It is for the colleges concerned to see that this requirement is satisfied.

The Admiralty has announced the appointment of Capt. H. P. Douglas to the post of Hydrographer of the Navy in succession to Vice-Admiral F. C. Learmonth, as from October 1 next. Capt. Douglas has been employed in the surveying branch of the Navy since 1897, and held the appointment of superintendent of charts in the hydrographic department from 1910 to 1914. During the War, he was employed on special surveying staff duties at the Dardanelles and with the Dover Patrol, in addition to acting as the first director of the Navy Meteorological Service (1917). For his preparatory work in connexion with the raid on Zeebrugge he was awarded the C.M.G. He was assistant hydrographer of the Navy from 1919 to 1921, and has since been in command of H.M. Surveying Ship *Mutine*, and her successor,

H.M.S. *Ormonde*, on the Bermuda and West Atlantic Survey. He is the inventor of several instruments and diagrams for use in surveying and navigation. The post of Hydrographer of the Navy (instituted in 1795) was originally tenable at their lordships' pleasure, and for an unspecified term. Admiral Beaufort, still remembered in connexion with the "Beaufort scale" of wind velocities, occupied the position for twenty-six years (1829–1855), and the late Rear-Admiral Sir William Wharton for twenty (1884–1904). Since the latter's time, however, the tenure of the post has been limited to five years, its successive occupants having been Admiral Sir A. Mostyn Field (1904–1909), Admiral Sir H. E. Purey-Cust (1909–1914), Vice-Admiral Sir J. F. Parry (1914–1919), whose grandfather, Sir W. E. Parry, the celebrated Arctic explorer, was Hydrographer in 1823–1829 and the present Hydrographer, Vice-Admiral F. C. Learmonth, who, before taking up his appointment as Hydrographer, was Director of Fixed Defences from 1914 to 1919, and in that capacity won unstinted praise from Lord Jellicoe for his work in the production of net defences, both for the British fleet and for those of the allies.

THE Council of the National Institute of Agricultural Botany announces that it proposes to place upon the market this autumn about 2500 quarters of a new seed wheat, Yeoman II., bred by Prof. R. H. Biffen; and tenders as to quantity are invited from established dealers in seed corn. The seed wheat will be sent out in sacks closed with the Institute's seal, none other being genuine, at the rate of 6*l.* 6*s.* per $4\frac{1}{2}$ cwt. Yeoman II. is intended to take the place of the older Yeoman wheat, partly because pure seed of the latter is now difficult to obtain owing to admixture with other wheat, partly because Yeoman II. is a better wheat in several respects. Both wheats are products of the same cross, Browick × Red Fife, and are similar in type. The yielding capacity of Yeoman II. has been tested out at ten different centres on varying soils throughout the country, with thoroughly satisfactory results. Comprehensive milling and baking trials made by impartial judges of the National Association of British and Irish Millers indicate that the bread made from the flour of Yeoman II. is of exceptionally good quality and is "incomparably superior to anything obtainable from average ordinary English wheat." In favourable seasons the loaves approximate closely to those from "No. 1 Manitoba" wheat. It is strongly advocated that from the different points of view of growers, millers, and consumers, Yeoman II. should take the place of the older form. It is particularly suitable for growing on medium and heavy soils which are in good heart, and is specially recommended for the eastern, midland, and southern counties of England, the best results being obtained with early sowing.

A TALK on "Life of the Sea-shore," by Mr. T. Howard Rogers, broadcast from the Birmingham Station of the British Broadcasting Co. on July 29, was the first of a series which will be continued until the end of the year by members of the Birmingham Natural History and Philosophical Society. On August 9, Mr. O. T. Elliott dealt with "Germs Beneficial and Otherwise," and the second and concluding part of his lecture will be given on August 1. Other talks which have been arranged are: "Butterflies," by Mr. J. H. Grant (Sept. 9); "The Earlier Known Life of the Earth," by Mr. Frank Raw (Sept. 17); "Flies," by Mr. Colbran J. Wainwright (Sept. 23); "Fossils," by Dr. L. J. Wills (Oct. 7); "How we get our Time," and "The Moon," by the Rev. T. S. Phillips (Oct. 14); "Plant-animals," by Dr. W. Elliott (Oct. 21); "Fairy Rings," by Dr. Jessie Bayliss Elliott (Oct. 28); "Algeria," by Capt. K. Shepherd (Nov. 4); "Shells," by Mr. H. Overton (Nov. 11); "Life of the Ocean," by Mr. T. Howard Rogers (Nov. 18); "Saturn," by Mr. S. C. Paris (Nov. 25); "Aquaria," by Mr. G. T. Calvert (Dec. 2); "The Modern School-boy," by Mr. F. W. Pilditch (Dec. 9); and "The Life-story of the Eel" by Dr. A. J. Grove (Dec. 30). The subjects are being dealt with in an interesting and non-technical manner; and it is hoped that these instructive talks which are addressed primarily to young people, will arouse interest in, and foster a taste for, natural history and kindred scientific subjects, and prove a helpful contribution to the valuable educational side of the programmes broadcast by the B.B.C.

IN connexion with the Exhibit in Gallery II. of the Government Pavilion at Wembley, by the Cambridge School of Agriculture, illustrating fertility and sterility in domestic animals, an excellent explanatory memorandum by Mr. J. Hammond has been issued by the Ministry of Agriculture and Fisheries. Sterility in the male is illustrated by microscopic preparations showing the semen of a sterile bull devoid of spermatozoa owing to the atrophy of the seminiferous cells —a condition which may follow inbreeding and other types of mismanagement. The reproductive process in the female is illustrated by a preparation of the reproductive organs of the cow, and the memorandum gives a short but clear summary of what is known of the physiology of these organs. Incidentally, mention is made of the striking demonstration of the control exercised by the corpus luteum over the ripening of the next Graafian follicle, that is obtained by expelling the corpus luteum from the ovary by simple pressure through the rectal wall, the result of this operative procedure being to bring on the next heat period before the time at which it would normally occur. Various causes of sterility in the cow are dealt with in the memorandum. The exhibit dealing with the sow illustrates the curious secondary limitation of fertility which occurs in this animal through degeneration and elimination of some of the embryos during the period of pregnancy, the potential brood of about 20 being reduced in this way to an average of about 8 or 9. In the rabbit such absorption of fœtuses is produced experimentally by removal of corpora lutea during early pregnancy, but in this case all the fœtuses disappear instead of only some of them as is the case in the sow. A similar result is seen in a rabbit which mates while still suckling a large litter, very active lactation having itself a

atrophic influence on the corpora lutea: in this case the effect may be prevented either by reducing the number in the litter to one or two, or by special feeding. The exhibit is one of much interest, and it will serve a good purpose by directing attention to the enlightened policy adopted by the Government of recent years, of encouraging research in external institutions such as Universities and independent laboratories.

Mitteilungen, No. 6, for June 1924, of the Society of German Men of Science and Physicians, are largely occupied by a discussion of the participation of Germany in international congresses. Léon Bourgeois is quoted as having said in 1913: "Coordonnons nos recherches, unissons et centralisons nos efforts, ne nous laissons distraire ni diviser par rien . . ." That was in the earlier days of tuberculosis inquiry, to which Koch, Ehrlich, and Behring have since contributed. Fritz Haber has spoken explicitly as president of the German Chemical Society meeting on May 12. He notes a mellowing of relations and a wish for closer scientific intercourse, expressed in particular by the United States, England, Russia, and Japan, as, for example, the invitations of the British Chemical Manufacturers and of the World Power Conference. The facts are given in greater detail in a paper on "International Scientific and Technical Congresses," pp. 53 to 67 of *Mitteilungen des Verbandes der Deutschen Hochschulen*, May 1924. The editor invites further reports directed to Johannisstr. 7, Münster in Westphalia. A list of 84 congresses is reviewed. Germans have joined in discussing physiology at Edinburgh, psychology at Oxford, orthopedics at Amsterdam, plant diseases at Wagening, serum at Copenhagen, pedagogy at Montreux, international law at Brussels, psychic sciences at Warsaw, dentistry in Paris, meteorology at Utrecht, gardening at Amsterdam, sociology in Rome, milk at Washington, philosophy in Naples, applied mechanics in Delft. Co-operation is absolutely necessary for the future of science, but much patience is required, for pressure in any direction might hinder more than help. The fullest list of international societies of all sorts is the "Répertoire des Organisations Internationales," published in Geneva for the Société des Nations. The director, Section of International Bureaux, League of Nations Secretariat, asks for information as to new societies or changes in older ones.

PROF. DR. RICHARD ZSIGMONDY, of Göttingen, has been elected a corresponding member of the Vienna Academy of Sciences.

A PROFESSOR of science is required at the Royal Military Academy, Woolwich, particulars of which can be obtained by written application from the Under Secretary of State, War Office (S.D.3), Whitehall, S.W.1. The completed form must be returned by August 21.

THE Department of Scientific and Industrial Research invites applications for the post of superintendent of its Chemical Research Laboratory. Candidates should have had experience of, and be distinguished in, some branch of pure or applied chemistry. Particulars of the duties of the post and a form of application are obtainable from the secretary of the department, 16 Old Queen Street, S.W.1. The latest date for the receipt of applications is September 30.

A SHORT time ago the question was raised in NATURE as to the possibility of registering priority in scientific discovery, on the analogy of a patent registering priority in invention. The device of sending in contributions under seal need not be forgotten. Even if afterwards published in some more finished form, the sealed documents should afford proof of the stage already reached at the date when they were handed in. The Academy of Sciences in Vienna reports the receipt of papers on the reproduction of lantern slides by an electrical method, on the action of Röntgen rays on organism, and a new treatment of carcinoma, a proof that the equation $x^n+y^n=z^n$ has no solution in rational numbers when n is greater than 2, and several other matters.

WE have received from the Russian Academy of Science of Leningrad the June issue of *Electritchestvo*. In honour of the centenary of Lord Kelvin it is called the "Lord Kelvin Number," and is devoted to articles in appreciation of his various activities by eminent men of science and engineers. The address presented at the Commemoration Celebration in London is quoted. "All Russian scientific men and engineers send their greetings to the Mother Country" of Lord Kelvin. "May the same spirit of sincere fellowship, which unites to-day the scientific workers of the whole world, form closer bonds between them for the benefit of humanity." Prof. Steklov, the vice-president of the Russian Academy of Science, writes an appreciation of the wonderful creative genius of Kelvin and his constant searchings after new physical laws. He, more than any one, tightened the bonds between pure science and engineering. Prof. Ossadchy, vice-president of the Gosplan, gives a résumé of Kelvin's work on telecommunication, and points out how its development was strongly influenced by his ideas. Prof. Châtelain, the president of the Russian Section of the International Electrotechnical Commission, discusses Lord Kelvin's work in the domain of electrical engineering. Its exceptional value lies in the fact that Kelvin laid sure foundations on which later workers have built a noble superstructure.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, announce for publication in the autumn a translation, by T. R. Parsons, of "Practical Physical and Colloid Chemistry for Students of Biology and Medicine," by Prof. L. Michaelis, of Berlin, which work was written to meet the needs of biologists and physicians desirous of becoming acquainted with the more important applications of physical and colloid chemistry to the problems of life and disease.

In order to show French textile manufacturers that it is no longer necessary to purchase their machinery outside France, M. A. Renouard has an article of 69 pages in the May Bulletin of the Société d'Encouragement. It is well illustrated and shows that, since the War, French textile machinists have introduced improvements into spinning frames, looms, and other machines which place them in the front rank.

The Department of Mines of the Queensland Geological Survey is issuing a series of reprints dealing with Industrial Minerals, giving a brief summary of the occurrences, treatment, uses, values, and production of these minerals, with special reference to Queensland resources. Nine of these pamphlets have been issued dealing respectively with salt, asbestos, mica, molybdenite, platinum, nickel, graphite, manganese, and arsenic.

In the Annual Report of the Raffles Museum and Library, Singapore, for the year 1922, Major J. C. Moulton gives a list of 44 specialists whom he has induced to assist in naming the collections of the museum. Progress has been chiefly marked in the insect collections, and many papers describing new species contained in them have been published. "As a result the museum is becoming more widely known as a *live* institution, and an increasing number of inquiries have been received from many distant parts of the world concerning the fauna of Malaya." It is to be hoped that this good work will continue in spite of Major Moulton's transference to a higher post.

Report No. 27 of the Industrial Fatigue Research Board records the results of investigations into the following industries: the textile, metal, boot and shoe, pottery, glass, and laundry, and into some repetition processes. It is thus a compilation by means of which the findings of different investigators in different industries can be conveniently compared. The various recommendations have been grouped under the following headings: (*a*) working conditions, (*b*) working methods, (*c*) administrative. It is only by the slow accumulation of data from many fields that generalisation of scientific value can be made. We are yet far from generalisation, but these studies show the direction in which available evidence points and suggest further developments.

Our Astronomical Column.

The Opposition of Mars.—At midnight on August 22-23, Mars will be nearer the earth than it has been for more than a century. The conditions are, in fact, the best possible for a close approach. These conditions are attained when opposition occurs a week before Mars passes perihelion, from the fact that the earth is then nearer to its aphelion.

At these close oppositions, Mars considerably outshines Jupiter, and its ruddy light renders it a very striking object. It is 10° further north than in June 1922, so that the conditions for observation in England are not quite so hopeless as they were then.

Unfortunately, these very near oppositions have seldom been so fruitful in telescopic discoveries as those occurring somewhat later in the year. Thus Schiaparelli's work on the canals was mainly done in 1879 and 1881, though he was observing in 1877.

The late Prof. Lowell, whose long-continued scrutiny of the planet under all possible conditions adds weight to his opinion, explained this by August oppositions occurring at the dead season of canal development, when the supply of moisture from one polar region had exhausted itself, and that from the other had not commenced. It is interesting to learn that his widow is visiting Flagstaff; her presence will doubtless encourage the observatory staff to make the most of their splendid equipment. The 24-inch Alvan Clark refractor, and the seeing conditions at a height of 7000 feet in the Arizona desert, are universally admitted to be unrivalled. Prof. W. H. Pickering is remaining at Mandeville, Jamaica, until after the opposition.

Sun-spot Activity.—A noticeable feature on the sun's surface since August 1 has been a well-defined circular spot, in latitude 6° north, which passed through the centre of the disc between August 6 and 7. The history of this spot has been followed on the Greenwich photographs since July 9, when a large bi-polar group commenced to develop in a small area of faculæ seen at the east limb of the sun on July 6. The total area of the group reached 1/2000 of the sun's visible hemisphere about July 13, after which the rear components disappeared, leaving the leader to continue uninterruptedly in the following rotation. No pronounced magnetic disturbance occurred at Greenwich when the spot was near the sun's central meridian.

The period embracing a solar minimum is well known as one of transition; the passing cycle is represented by sporadic spots near the equator, whilst the spots of the coming cycle are appearing in higher latitudes (20°-35°). The last solar minimum is now definitely concluded, and although small equatorial spots might have been expected, a spot group of this extent and length of life is remarkable. It will afford additional data for determinations of magnetic polarities at Mt. Wilson, which are of added interest at this phase of the solar cycle in view of the observed reversal of polarities.

Two Notable Variable Stars.—The June Monthly Notices of the Royal Astronomical Society contain papers on the well-known variables Mira Ceti and β Lyræ.

The former is discussed by Dr. W. J. S. Lockyer, the star having been observed both for magnitude and spectrum at the Norman Lockyer Observatory, Sidmouth, last winter. The maximum was attained on January 29, in accord with Leon Campbell's prediction; the star was unusually faint, only rising to 4·9 mag., whereas it attained 2·2 mag. in 1906; it seems to have been the faintest maximum since 1886. The bright hydrogen lines were also feebler than usual; a discussion is given of their relative brightness. The more prominent dark lines were also studied, and indicated the presence of calcium, manganese, iron, aluminium, strontium, chromium, titanium. It was noted that there were several instances of the intervals between absorption lines having previously been mistaken for bright lines, and that apparently the only bright lines present are those of hydrogen.

Miss M. A. Blagg contributes a long paper on Baxendell's observations of β Lyræ, which ranged from 1840 to 1877. She concludes that the period is increasing, and gives the following formula for principal minimum: Julian Day $2398590{\cdot}57 + 12{\cdot}908\,E + {\cdot}0000037\,E^2$. She also finds a subsidiary variation with a period of 6·576 days; the fact of its being so nearly half the principal period increased the difficulty of analysis.

Research Items.

An Amerind Type from China.—Prof. Seligman ures in *Man* for August two examples of Chinese t of the T'ang period which provide a striking rroboration of the view put forward by Dr. dlička on several occasions, notably at the Nine- enth International Congress of Americanists (*vide* oceedings XIX. Int. Congress Americanists, p. 5), that a type identical with, or close to, the nerican Indian occurs over a wide area in Eastern ia. The first of these is a whistle, roughly spherical form, of a well-baked whitish paste, representing head, of which the face and scalp are covered with dull light green glaze. This might perhaps have en regarded as a freak, had it not been for a second d more striking specimen in the Eumorfopoulos llection. This is a small figurine of much the same ality as the whistle, and also covered with green ze. In both cases the features are distinctly nerind in cast, while the treatment of the hair ggests the lank locks of the characteristic American dian type.

Molluscan Problems.—The crystalline style of olluscs has always puzzled biologists, and even now ere is no clear indication of its full functions. obson performed a useful service in collecting gether all records of its occurrence not only in imellibranchs but also in Gastropods, and any mprehensive view of its function must apply to th these groups. Many writers have shown cently that the style contains an amylolytic ferment certain forms, but other equally good workers have t been able to find significant quantities of ferment the style of other species. There is therefore room r a comprehensive piece of work on this aspect the question, since generalisations from results of periments on a few animals are not yet valid. uxley suggested long ago that the style probably volved in the stomach, and Nelson has seen the volutions in a few bivalves, but more observations e again needed, as also of the use of the style to aw into the stomach the food-entangling mucus- rings as described by Orton and Worsnop in the ster. The ready solution of this organ in un- vourable conditions in some forms and its high sistance to solution in others indicates that the style ay have somewhat different functions even in closely lated animals. We shall therefore not be in a position dogmatise on the function of the style in molluscs til a great deal more information has been collected. nother old molluscan problem, which was regarded of great moment at one time, namely, the question the possibility of the intake of sea-water, has parently been settled. Pelseneer long ago acknow- dged the occurrence of a water system in the foot Naticidæ, but completely separated from the rculatory system and used for distending the foot burrowing, and similar cases have been recorded Lewis and by Mitra, who was also one of the first orkers to demonstrate the existence of a ferment the crystalline style. But no case of direct com- unication between the blood system and the terior has yet been demonstrated, and seems un- kely to occur. There still remains, however, the oblem of the possible absorption of water into the stem, either over the whole exposed surface or rtions of the surface of the body of a mollusc.

The Twinning and Monembryonic Develop- ent of Platygaster.—Messrs. R. W. Leiby and C. Hill contribute an interesting account (*Journ. gr. Res.*, Washington, vol. 25, No. 8, 1923) of the development of *Platygaster hiemalis*, a hymenopterous parasite of the Hessian fly. The female deposits a group of four to eight eggs in the egg or in the young larva of the host. During maturation two polar bodies are formed in the egg, and these unite to form a single polar nucleus in the anterior region of the egg. Maturation is stated to be identical in fertilised and in unfertilised eggs. After maturation the male and female pronuclei fuse to form the cleavage nucleus, which lies in the posterior part of the egg. In the unfertilised egg the female pronucleus is found in a corresponding position. The portion of the egg containing the cleavage nucleus becomes differentiated and forms the embryonic region; the remainder of the egg containing the polar nucleus is homologous with the trophamnion and paranucleus of previously described polyembryonic insects—its function is to nourish the embryos until they are young larvæ, and can feed for themselves upon the host. The embryonic nucleus and the polar nucleus each undergo division into two and then four. The embryonic region in some of the eggs then divides to form two embryonic regions which become separated from each other—each carrying with it two of the four paranuclear masses. This separation results in the production of twin germs, each of which develops into a larva. The embryonic region of other eggs does not separate into two, and such eggs produce a single larva. The twinning development, here described for the first time, illustrates a simple type of polyembryony.

Rainfall in Australia.—The rain map of Australia for 1923 compiled by the Commonwealth Meteorologist shows the distribution of rain for the year and for each separate month. There are also a number of charts showing the areas with rainfall above the average in recent years. The chief maps are based on the records of some 1300 well-distributed stations. About 22 per cent. of the continent had a rainfall above the normal, but the excess was mainly in the west, south-east, and Tasmania, while in 1922, when the area of excess reached about the same percentage, it was mainly in the north. In Queensland and parts of northern New South Wales, the dry conditions which had prevailed in 1922 continued and intensified into conditions of severe drought. It was only in June and December that the rainfall was at all satisfactory. In south-eastern Australia the fall was poor during the first half of the year. Conditions during the cereal-growing period were very favourable throughout most of the wheat region, but in northern New South Wales and Queensland crops failed on account of the drought.

Opalescence at and near the Critical Point.—M. A. Audaut, in the May-June number of the *Annales de Physique*, describes a very comprehensive investigation of this phenomenon for five liquids with high critical temperatures. He measured both the diminution of the intensity of the transmitted light, and the intensity of the light scattered at right angles to the line of incidence, and found that the critical opalescence has the same intensity for a given substance when the experimental conditions are the same, and is not due to dust or impurities. Slow change of temperature and thorough stirring are necessary to obtain well-defined opalescence, a rate of one degree change per hour having been adopted. The opalescence was found to be a function of the temperature, of the wave-length of the light employed, of the amount of substance in the tube, the "filling," and

of the nature of the substance. The appearances observed at different temperatures and with different fillings agree with the theory of Einstein and Smoluchowski, which explains the opalescence as due to molecular agitation, using the analogy of Brownian movements. There is a critical filling, with maximum opalescence, which in this case is found at the same temperature with rising and with falling temperature; this temperature coincides with the critical temperature, which can be determined with accuracy by measurements with different fillings. The method gives for ether and ethyl acetate 193·3° and 249·8° for the critical temperatures, and 0·259 and 0·306 for the critical densities. The number, N, of the molecular aggregates concerned per c.c. can be deduced by means of the theory from the observations of the opalescence; for ether, at 2·5° above its critical temperature, two values were obtained for N: 62×10^{22} and 58×10^{22}.

ADSORPTION AND CATAPHORESIS.—In the *Comptes rendus* of the Paris Acad. Sci., June 23, M. K. v. d. Grinten describes observations made with the ultramicroscope on a suspension of fine particles of the same glass as that employed in the construction of the trough containing it. Platinum electrodes 40 cm. apart were placed in the trough, and the potential difference between them was 10 volts. The velocity of the particles near the glass walls was in the opposite direction to that of those midway between them; the velocity of the latter, near the positive pole, was double that along the wall near the negative pole. When the thickness of the trough is more than 0·5 mm. the velocity of the particles in the middle region no longer varies with the thickness. This indicates that the liquid in the middle region remains at rest and the measured velocity is the true velocity of the particles with respect to the liquid. If electrolytes are added the cations of which are adsorbed, the velocity of the particles diminishes, and reverses for a certain concentration of the electrolyte. Methyl violet (*violet crystallisé*) was used as the added electrolyte, and the maximum number of molecules adsorbed per sq. cm. of glass sheet was found to be $1{\cdot}6 \times 10^{14}$. At small concentrations the adsorption grows rapidly with the concentration, but from the concentration $n/10000$ on it grows less rapidly towards the maximum, when it is concluded that a monomolecular layer is formed over the whole surface of the glass. The curve showing the relation of the cataphoresis velocity to the concentration, and that showing the relation of the number of adsorbed molecules per sq. cm. to the concentration, have the same form; starting from concentration $n/10000$, the two curves rise almost perpendicularly to the X axis. Similar results were obtained with suspensions of selenium. It appears then that each particle in the suspension is covered with a monomolecular layer when a certain concentration is reached.

WHAT IS MATTER?—In the issues of *Die Naturwissenschaften* for July 11, 18, and 25, Prof. H. Wehl, of Zurich, passes in review the various answers which have been given to this question. Of these the older "substance theory" has played its part and disappeared, leaving the "field theories" of Mie and others and the "dynamical theories" in possession of the stage. Some form of dynamical theory gives, according to Wehl, the greatest insight into the question, and he outlines his own view as follows: Matter is an agency which generates a field, the field a medium which propagates the action of one body on another. An "active mass" m generates about itself a field $m/4\pi r^2$ and a "passive mass" m' placed in this field is acted on by force $mm'/4\pi r^2$. By a proper choice of units the passive and active masses of body may be made identical, and the conception the field as a flux from the active mass gives t inertia of the mass as due to the field it generat about itself.

DEVELOPMENT OF PHOTOGRAPHIC LENSES.—Tho who are interested in the history of the developme of lenses for photography will find in the Augu number of the Royal Photographic Society's Journ an exceptionally valuable contribution by Pr Moritz von Rohr. Since the publication of h "Theory and History of the Photographic Objective in 1899, he has found many new facts, and it is the that he here records. He refers to work by Scheiner in 1618, J. G. Leutmann in 1719, Thom Young in 1800, Coddington, Airy, and others, in t prephotographic period. Then follow accounts A. S. Wolcott's pioneer work in 1843 (who appears have been the first to produce a symmetrical doubl and a revolving diaphragm), a symmetrical doubl with plane cemented surfaces by H. Fitz, and t efforts of American opticians (1860–66) in the pr duction of wide angle lenses. The great theoretic importance as well as the practical efficiency of t negative lens used by Piazzi Smyth to flatten t field of the portrait lens in his small camera that to plates one inch square is discussed. The author h obtained from Mr. J. Stuart two letters written Monckhoven (1865–67) recommending Thomas Ro to take up the manufacture of H. A. Steinheil's aplanats. A full translation of these letters is give and the originals were presented to the Royal Phot graphic Society. The paper concludes with a lo list of references to the sources of information.

CHEMISTRY OF INSULIN.—*Chemistry and Indust* of July 18 contains an account of a paper by Mr. F. Carr, of British Drug Houses, on the manufacture insulin. An account of what is known of the chemistr of insulin, the most important property of which is i action in causing the disappearance of glucose fro diabetic blood, at the rate of 3 grams of sugar p 0·0001 gram of insulin in two hours, is first give Insulin appears to be sparingly soluble in water at i isoelectric point of $P_H = 5{\cdot}2$, but readily soluble a other points near neutrality, precipitated by ha saturation with ammonium sulphate and sodiu chloride and other reagents, insoluble in absolut alcohol, free from phosphorus, tryptophane, an tyrosine when pure, but containing organic sulphu Insulin from ox-pancreas gives the biuret reactio but that from skate-pancreas does not. It does n pass a collodion ultrafilter and is destroyed by pepsi and trypsin, and therefore appears to be of protei like structure. Insulin is extracted from anima pancreas, which is the part of the body in which it mainly stored, and recent experiments show that i is present in a more easily separable form in man fishes near the gall bladder. The method of manu facture is rather complicated, but depends essentiall on extracting the disintegrated pancreas, rendere acid to P_H 2·5 or alkaline to P_H 7·0, with 65-70 pe cent. alcohol, in which little enzyme is dissolve cooling to −5°, filtering or centrifuging, concentratin at low temperature to one-tenth the volume, extract ing the fat, precipitating the proteins with absolut alcohol or ammonium sulphate at P_H 5 and furthe separation of the separated proteins with alcohol an picric acid. The large scale operation is continuous and a flow sheet is given. As a result of improvements the selling price of insulin has been reduced fro 25*s.* to 2*s.* 8*d.* for ten doses. The really wonderfu results of insulin treatment in advanced cases o diabetes are set out.

The Fourth International Congress of Refrigeration.

THE fourth International Congress of Refrigeration was held in London in June last. The Congress was organised by a committee of the British Cold Storage and Ice Association, working in conjunction with the Institut International du Froid. This International Institute is an organisation in which each State, Dominion, or Colony, signatory to the International Convention, is represented by delegates appointed by the participant State in a number proportioned in accordance with the amount of annual subsidy, varying from 1000 to 12,000 francs. It is interesting to note that forty-eight countries have signed the International Convention.

The Institute devotes its energies to further the science of refrigeration; to encourage the study of the best solutions of questions relating to the conservation, the transit, and the distribution of perishable produce; to the publication of all information relating to the world's frozen-food situation.

The study of the above-mentioned subjects is pursued by sixteen separate commissions. The function of the International Congresses is to co-ordinate and afford a common meeting ground for the members of these commissions and to all interested in refrigeration.

The work of the London Congress was subdivided between seven sections dealing respectively with: 1. Scientific Questions—Physics, Units, and Biology. 2. Refrigerating Materials—Machines, Insulating Materials and Testing. 3. General Applications of Refrigeration—Food, Agriculture, Ice, etc. 4. Refrigerated Transport—Railway and Steamship. 5. Legislation. 6. Education and Propaganda. 7. General Economics and Statistics. Thus one section would embrace the subjects coming within the purview of a number of separate commissions.

The meetings of the Congress were well attended by those engaged in the practical side of refrigeration. The title "Congress of Refrigeration" failed to attract many physicists, although Section 1 had on its programme a fine series of papers from the Leyden Cryogenic Laboratory.

The character of the papers will be realised from the following titles selected at random: "Organisation of the Work of Commission No. 1" (Kamerlingh Onnes). "Report on the Freezing Point Temperatures of Organic Substances suitable for Use as Reference Points for the Low Temperature Scale" (Jean Timmermans). "The Isotherms of Hydrogen, from −217° C. to −240° C." (J. C. Swallow). "Report on the X-ray Investigation of the Constitution of the Liquid and Solid States of Substances at Low Temperatures" (W. H. Keesom). "Low Temperature Investigations in the Service of Cosmical Physics" (L. Vegard).

The papers of a biological character submitted to Section 1 were rather disappointing, and it was evident that the majority of the contributors did not regard the Congress as the place to discuss purely scientific matters. It is a pity that this outlook should prevail, for it is obvious that an international congress which gathers under one roof the diverse interests concerned can exert an enormous influence on the progress of refrigeration on both the theoretical and the practical sides. Hence, on the purely biological side of the science of refrigeration there is but little which calls for comment, so far as the present Congress is concerned.

Some of the most interesting of the papers on the practical side were those dealing with the transport of refrigerated produce by land and sea and those on special applications of refrigeration. Of the papers dealing with the marine side, one might be mentioned —"Special Methods of Construction of Ships and Refrigerating Appliances for Vessels employed on Long Voyages" (A. R. T. Woods).

As regards land transport, the paper on "The Influence of Refrigeration in the Preservation of Fruit with Special Reference to South African Export Varieties" (I. B. Pole-Evans and Edgar A. Griffiths) is noteworthy, as it records the results of experiments on special trucks carrying fruit a distance of 1000 miles through semi-tropical heat.

The paper on "Temperature and Metabolic Balance in Living Plant Tissues" (F. Kidd and C. West) is a useful sketch of some recent work in America and Germany.

The work of the Insulation Sub-Committee of the Food Investigation Board was summarised in a paper of about eighty pages with the title "The Scientific Study of Heating Insulating Materials" (Sir Richard Glazebrook and E. Griffiths).

An interesting contribution on one of the special applications of refrigeration was that on "The Application of Refrigeration to the Ventilation of Mines" (F. A. Willcox and J. D. Farmer).

Mr. W. B. Hardy, director of the Food Investigation Board, gave an admirable sketch of what he considered to be the correct function of the Food Investigation Board and the work of a research station. He pointed out that of the problems which an industry presents, some are fundamental and far-reaching, others special and local. He quoted two examples to illustrate what the Board conceived to be their special province of work. One was the problem of the freezing of beef and most white fish. Can these materials be so frozen as to recover their original state on thawing? When beef is thawed after being frozen, its texture is impaired, and it drips a fluid rich in dissolved nutritive material. This is due to that separation of water from other constituents which is a common feature in the freezing of solutions. Is it possible so to modify the whole cycle of physical events compressed in freezing and thawing as to bring this separation of water under such control as will lie within the four corners of a possible commercial process? No answer is yet forthcoming, because the theory of the freezing of tissues is yet in its infancy. Animal tissues are colloidal structures, and of the effects of low temperatures on colloids little is known. This is a fundamental problem because its solution involves the whole theory of the freezing of tissues. If and when it is solved, and it may be years before that difficult end is attained, any feat of freezing should be possible, or, to be more exact, the possibilities and impossibilities of freezing as a mode of preserving animal or plant tissues should be capable of fairly exact delimitation.

The other problem put forward by Mr. Hardy was purely physical. The Board were consulted as to the following:

A certain store was cooled by a fan driving air over calcium chloride brine, the cold air being then supposed to circulate throughout the chamber. Meat stored there became discoloured and unpleasant to sight and touch. This was ascribed to putrefactive organisms—to bacteria, in short. The solution of the problem proved simple. Bacteria as the *causa vera* were readily ruled out. The wind from the fan produced an invisibly fine spray of brine which settled on the surface of the carcases, where the calcium chloride reacted with the red colouring matter hæmoglobin to produce methæmoglobin. The scientific interest up to this point is small, and the problem,

though of some practical interest, does not rise above the level of the ordinary works laboratory. A study of the air currents in the chamber, however, revealed the fact that the fan, though seemingly placed where it would circulate the whole body of enclosed air, did as a matter of fact merely puddle in its own neighbourhood, producing powerful vortices on the surface of the brine. This and many similar instances have convinced the Board that the principles which underlie the movement of air in a space partly occupied by solid masses, such as the cargo in a hold, or the carcases in a store, are not clear, and therefore they have arranged that this general fundamental inquiry shall be prosecuted at the National Physical Laboratory.

This example will serve to show how the particular leads to the general; but general solutions are not reached readily, and, therefore, if each particular problem is regarded only as the door to the general, the number of problems which can be undertaken by the small staff at the disposal of the Board is limited.

The papers on the practical engineering aspect f cold storage were so numerous, and the impressi which the Congress left upon one was that t progress made on the purely technical side has been considerable, that it threw into strong relief t inadequacy of our knowledge on the fundamen problems of biology.

A Congress such as the one under review, with strong international backing, should have been t occasion for a frank review of the situation and discussions on the fundamental problems with whi the industry is faced. The proceedings of the successive congresses could be made to serve definite landmarks in the history of the science refrigeration by epitomising the advances made the intervening years both in pure and appli science, in so far as they relate to the preservation perishable food-stuffs, and by formulating the gene plans of attack on the new problems.

EZER GRIFFITHS.

Mechanism of Cell Growth.

IN the higher plants, new cells are formed and new tissues arise by the activity of certain definitely localised and clearly characterised tissues, the meristems. In the Dicotyledon, these are found at the apex of root and shoot, that is, at either end of the growing axis; in addition, two continuous cylinders of meristem, the cork phellogen and vascular cambium, run lengthwise through the axis and contribute to its subsequent increase in girth. Within these meristems proceeds the construction of new protoplasm, with subsequent mitotic division into new cells as nuclear and cytoplasmic substance accumulates. In such a plant, then, the fundamental metabolic synthesis inseparable from growth, with the subsequent multiplication of the cells of the embryonic tissue, can be visualised as proceeding in strictly localised regions, and the question as to the conditions which promote such growth and division can to some extent be investigated experimentally. Within recent years the meristems have been examined from this point of view. It is clear that if their investigation gives any information as to the condition favouring such a fundamental process as the growth and multiplication of embryonic cells, this information may have very general importance and illuminate a wide range of problems.

From this point of view, an article by Friedl Weber in *Die Naturwissenschaften* for April 18 is of exceptional interest, as it reviews the recent plant physiological approach to these problems from a wide angle and with a wealth of documentation (for citation to original papers referred to below, reference must be made to Weber's paper).

The best known contribution to the conditions governing meristem activity is Haberlandt's theory as to the circumstances which give rise to a new meristem when the plant is wounded and a cork phellogen arises as a result. In this case, cells that have differentiated, and ceased to grow, return again to the embryonic state, and Haberlandt traces this to the effect upon these cells of growth-promoting hormones released from the injured cells. Weber examines the view sympathetically, and has himself used it to explain the forcing of buds from their winter's rest by freezing, narcotics, and various other methods by the assumption that the efficacity of the treatment depends upon the release of such hormones as the result of "physiological wounds" within the bud. Schillings' experiments, however, in which stems of flax and hemp, bent so that they droop earthwards, grow vigorously in the region the flexure, tell strongly against Haberlandt's vie as this stimulus to growth disappears, although t injury does not, when the shoot is supported in t erect position after bending. But the greatest d advantage of Haberlandt's view is that it throws light upon the normal meristematic activity of t uninjured plant.

From this point of view, therefore, Weber finds wider significance in the views recently develop by Priestley and Woffenden. These investigato similarly start from an examination of wound co but the conclusions they reach that its formati depends upon, first, a blocking of the wounded surfa and then an accumulation of sap in the walls a intercellular spaces below this block, enable the by consistent use of the same developmental facto to give a causal explanation of the position of t normal cork phellogen clothing root and ste Weber then proceeds to a discussion of the mo general suggestion as to the conditions for activi of the intercalary meristems of the Dicotyledo recently advanced by Pearsall and Priestley. The authors have pointed out that these two cylinde of meristem appear to be functioning across tv reverse gradients of hydrogen ion concentration, t vascular cambium lying between acid xylem within a relatively alkaline phloem without, whilst the co phellogen has within it the cortex at about P_H but outside it cells, the walls of which are bath in fatty acids with a reaction of $P_H 3$. Web examines in the light of a wealth of relevant da the suggestion of Pearsall and Priestley that prot plasmic synthesis, and therefore meristem activit takes place, across this gradient, at the iso-electr point of the cell proteins, the protoplasm at th reaction losing water to cells on either side whic being at other points on the hydrogen ion gradien swell and vacuolate, withdrawing water from th meristem.

Weber points out that many other physico-chemic properties of the colloidal state of protoplasm a involved in addition to the power of absorbing wate and emphasises that the delicate equilibrium of thes properties, which alone permits of protoplasmi synthesis and mitotic division, probably will onl be maintained over a limited range of hydrogen-io concentration. From this point of view, he re examines Kühns' classical experiments upon nuclea and cell division in Amœba, and directs special atter tion to the experiments which, by micro-dissection c

by other methods, throw light upon protoplasmic viscosity, and show that alterations of viscosity are quite generally characteristic of mitosis and the activities of embryonal cells.

From the same point of view, Weber points out that high temperatures, narcotics, and other factors influencing mitosis are factors capable of influencing protoplasmic viscosity, as shown by Heilbrunn in his experiments upon sea-urchin eggs. Similarly, Koernicke has shown that under X-rays, and Hartmann that at high temperatures, all the cells of the meristem of the root apex vacuolate. Weber also points out that the rounded nucleus characteristic of the embryonic cell suggests a different and more plastic physical state of nuclear protoplasm, so that the shape is more controlled by surface tension than in the case of the variously shaped nucleus of the differentiated cell that has ceased to divide.

Weber marshals much evidence to show that the hydrogen-ion concentration of the medium can affect the physico-chemical state of the protoplasm, and directs attention to Spek's interesting suggestion that at mitosis, a base, the bye-product of nuclein synthesis, escapes into the cytoplasm with consequent swelling of the plasma colloids and as a result a stimulus to increased nuclein synthesis, so that the process is autocatalytic. Spek explains the cessation of cell division as brought about by a change in permeability permitting increased entry of salts, which neutralise the action of the base released from the nucleus. Certainly in the mitosis of sea-urchin eggs the influence of the hydrogen-ion concentration of the medium has been established as in the experiments of Vles and his co-workers. Lyon has shown that the carbon dioxide production during mitosis varies at the different stages recognised by the cytologist, whilst Jacobs has tried to correlate these striking fluctuations in carbon dioxide output with the equally striking viscosity changes. As Weber points out, such fluctuation of carbon dioxide output will influence the difference between the reaction of the egg plasma and the outside medium.

The rhythm of cell division may find some explanation in the respiratory production of carbon dioxide. Thus Lapicque has shown that the reaction of the medium in which Spirogyra is growing is affected by carbon dioxide production in the dark and its disappearance during photosynthesis in light, and Weber suggests that here may lie the explanation of the fact that cell division in this plant occurs only at night.

Starling is cited for the view that the problem of cancer is the problem of the control of cell growth. Recent studies of cancer with physico-chemical methods enable Weber to refer to investigations indicating that the cancer cell owes its peculiar growth qualities to the medium, the tumour plasma, in which it lies, and that one important factor of this medium is hydrogen-ion concentration.

Weber thus brings a very wide range of phenomena of great general interest under review, and points out in conclusion that the suggestion of Pearsall and Priestley, that the hydrogen-ion concentration is a material factor in meristematic growth, admits of experimental investigation, Heilbrunn, Meier, Endler, and Robbins, amongst others, having suggested methods for determining the iso-electric point of the protoplasm.

Cambridge and the Royal Commission.

PROVISIONAL SCHEME.

THE University Commissioners have communicated to the University of Cambridge a provisional scheme for the inauguration and organisation of teaching in the University on the general lines of the recommendations of the Royal Commission. They propose to draft necessary statutes and ordinances themselves to carry out their scheme, but publish their proposals in outline in order to give members of the University an opportunity of expressing their opinion about the proposals.

It is proposed to constitute as from October 1, 1926, eleven faculties in the arts group and seven in the science group. In the science group there are to be agriculture, biology, engineering studies (including aeronautics), geographical and ethnological studies, mathematics (including astronomy and geodesy), medicine, physics, and chemistry. The faculty of biological studies is to be divided into two sections, each with separate departments: A. (1) botany, (2) genetics, (3) geology, and (4) zoology. B. (1) biochemistry, (2) experimental psychology, (3) human anatomy, (4) parasitology, (5) pathology, (6) physiology. The faculty of physics and chemistry is to include the following departments: (1) astrophysics, (2) chemistry, (3) mineralogy, (4) physics.

The separate faculties will be composed of official university and college teachers in the appropriate subjects (including fellows of Girton and Newnham Colleges) and others appointed by the Board of the Faculty. The Board of a Faculty will consist of the professors in the subjects concerned, a certain number of nominees of the faculty, of the Board and of the Council of the Senate, together with representatives of cognate studies. The average number of members of a Board, according to the detailed scheme suggested by the Commissioners, is sixteen.

The new General Board of Studies is to consist of four members elected by the group of arts faculties, four members elected by the group of science faculties, four members of the Council of the Senate, and two persons nominated by the Council, with the vice-chancellor as chairman. The number of university lectureships (and demonstratorships) would be determined by the University for each faculty on the recommendation of the Board of the Faculty and of the General Board. The appointments would be made by a standing committee for each faculty of the vice-chancellor, the head of the department, three members of the Board of the Faculty appointed by the Board, and two persons appointed by the General Board. The normal tenure would be for three years in the first instance, and, on renewal, so long as the lecturer was doing his work satisfactorily, until the retiring age of sixty-five.

According to the scheme, all fees for lectures announced by the General Board would be paid to the University into faculty or departmental funds, the lecturers to be paid a basic wage by the faculty for an obligatory minimum of teaching work, with a scale of increments on the basic salary, with continued tenure of a post, and with additional payments for extra work done. It is contemplated that the University will be able to inform the faculties, before they finally create their new lectureships, how much money, if any, the University can put at the disposal of each faculty board in addition to the fees credited to it.

A great amount of work must lie before the Commissioners and various bodies of the University in getting the scheme into working order; a great amount of work must have been done on it already. It represents the completion of a process which has

been going on for a considerable time by which the organisation of the teaching and the actual teaching itself has been slowly but steadily passing out of the hands of college lecturers into those of university staffs. The creation of the large scientific laboratories and departments has accelerated the change, which is already half completed. The University takes more conscious control of developments and changes in studies. It remains to be seen whether improved organisation will mean better efficiency or whether the initiative of individual colleges fostered in the past may be crushed by the burden of machinery. As ever in such cases, it all depends on the quality of the men who become responsible for driving the machine.

Among other proposals which the Commissioners contemplate is permission for a professor to be continued in office after reaching the age of sixty-five up to, but not beyond, the age of seventy. They also contemplate throwing open all professorships, readerships, lectureships, and examinerships to women. This proposal to put women teachers on the same footing as men in the matter of the organisation of teaching removes one of the serious grievances remaining for women at the University. Even though they may not vote in the final decisions of the Senate on matters of educational policy, they will be free as members of a faculty to take part in the more important preliminary discussions which ultimately determine the changes of policy. The Commissioners do not propose to force upon the University, against its expressed wish, the admission of women to membership and to a share in the government of the University. That is to be left to the University itself to settle.

University and Educational Intelligence.

BRISTOL.—A prospectus of the Faculty of Engineering, which is provided and maintained by the Society of Merchant Venturers in the Merchant Venturers' Technical College, Bristol, has just reached us. Courses of study are available at the College for persons intending to engage in civil, mechanical, electrical, or automobile engineering, and particulars of these courses are given in the prospectus. The ordinances and regulations relating to degrees and diplomas in engineering subjects are included, and some particulars of the Bristol sandwich-system of training engineers are also given. The prospectus can be obtained from the registrar of the Merchant Venturers' Technical College, Bristol.

CAMBRIDGE.—Mr. W. S. Thatcher has been appointed Censor of the Non-Collegiate Students.

LEEDS.—With the view of encouraging the revival of the University Extension movement, the West Riding Education Committee has decided to make towards the cost of an approved course of extension lectures such a grant as will cover the actual deficit incurred, or 75 per cent. of the total expenditure, on condition that at least 30 persons undertake to enter for the whole course, and that the lectures are open to the public at a charge not exceeding 3*d*. per single lecture. The fees for lectures range from 22*l*. 10*s*. for a course of 6 to 76*l*. 10*s*. for 24, and the only other charges besides incidental local expenses, such as hire of hall and advertising, which are borne by the local committee, are the lecturer's travelling expenses and a fee of not less than two guineas (varying according to the number of candidates) for the examination, if one is held. The panel of lecturers includes 33 members of the University staff, of whom 8 are professors. The range of subjects is very wide: the following are specimen headings—Greek ethics, archæology and architecture, phonetics, the Irish literary movement, social psychology, riches and poverty, Spanish art, How the Empire is governed, French history since 1815, the gases of the atmosphere, fresh-water biology, types of respiratory structure, the antiquity of man, radio-activity, application of colloid chemistry to industry, British birds, enzymes, bacteriology from the medical, public health, and chemical points of view, personal hygiene.

AN advisory chemist in the faculty of agriculture, University College, Reading, is shortly to be appointed. Particulars are obtainable from the Registrar of the College.

THE trustees of the Busk studentship in aeronautics, founded in memory of Edward Teshmaker Busk, who lost his life in 1914 while flying an experimental aeroplane, have appointed Mr. John Cowan Stevenson, of the University of Glasgow, to the vacant studentship.

A DEMONSTRATOR is required in the mathematics and mechanics department of the Royal College of Science, South Kensington. Candidates must possess engineering experience, and send their applications to the secretary of the college not later than September 5.

APPLICATIONS are invited by the Director of the School of Medicine, Cairo, for the professorships in the school, of Physics, Clinical Medicine, and Clinical Surgery; also for the post of lecturer in physics in the institution. In the latter case candidates must be of Egyptian nationality. Applications must reach the director by September 15 at latest.

APPLICATIONS are invited for the appointment of lecturer in physics and the directorship of the Viriamu Jones Physical Research Laboratory of the University College of South Wales and Monmouthshire. Applications (six in number) and testimonials must be received not later than September 10 by the Registrar of the College, Cathays Park, Cardiff.

THE University of Calcutta "Poverty problem study" organisation which has been at work for some years has succeeded in promoting the formation of a limited liability company for the establishment in the Pareshnath Hills of co-operative educational colonies, such as Capt. Petavel, Principal of the Kassimbazar Institute, has been advocating in his university lectures on the "Poverty problem." The Company proposes to set up an agricultural college "where professors and students will be provided with sufficient land for self-support and education." Each student on completion of his course, and having obtained a university diploma, would be helped to acquire, as a member of a colony, a plot of ground with bungalow, well, bullocks, plough, etc. The scheme is described in the first number of a new periodical, "Bread and Freedom," edited by Capt. Petavel.

INTERCHANGE of teachers between universities within the Empire is one of the subjects that were discussed at the recent Imperial Education Conference in London organised by the League of the Empire. One speaker described as an object lesson to the universities of the Empire the Chicago University summer school, which attracts professors and lecturers from all parts of the United States as well as from abroad. We have lately received a University of Colorado Bulletin which gives an account of this University's summer quarter, extending from the middle of June to the end of August. This year the staff includes no less than fifty instructors from other

stitutions, among whom are professors and other embers of the staffs of universities in twenty other tates. Many are, no doubt, attracted by the niversity's advantages of climate and picturesque rroundings. A permanent camp is maintained uring the summer quarter at Arapahoe Falls in the ocky Mountains, about 25 miles distant, for the enefit of university students and teachers.

Adult education in Ireland was the subject of an ddress by Mr. George Fletcher, of the Department f Agriculture and Technical Instruction for Ireland, t the annual congress of the Irish Technical Instruction Association on June 4. For many years there ave been complaints that the effectiveness of echnical instruction in Ireland is much less than it ight be, because the standard of general knowledge f the students is low. It is mainly on the ground hat it would remedy this defect that Mr. Fletcher rges the inauguration of schemes for the extension f University teaching in towns and for the establishment of community centres with village halls in ural districts. Hitherto there has been no movement in this direction in Ireland comparable with the University Extension movement in England. The Royal Dublin Society, a few years ago, allocated 200*l.* or the initiation of courses of lectures; a panel of ecturers was framed and syllabuses were prepared, ut the work had barely begun when travelling became almost impossible, and the scheme was bandoned as impracticable. Its resuscitation has ow been recommended. It is thought that the ransfer of Technical Instruction from the Department of Agriculture and Technical Instruction to the Department of Education, which took place on June 2, 924, may tend to the establishment of conditions avourable for voluntary enterprises in the field of dult education.

"Non-university resources for graduate study and esearch" formed the subject of two interesting papers ead before the Association of American Universities ast November and published recently. President Wilbur, of Stanford University, argued in favour of all ew research projects being brought directly into the domain of some university or group of universities, nd also against the constitution of "research rofessorships" and special research institutes isolated rom "the great normal university current." In ertain fields the Pasteur Institute, the Rockefeller nstitute in New York City, and other organisations or research independent of universities have not nly achieved conspicuous success but have also "set he pace" for university research work. This kind f development of research is, however, less advantageous to the community than development within the universities, for the following reasons: ts overhead expenses are greater, it does not provide uch good opportunities for the training of young esearch students, or for the benefits of membership f a faculty and association with members of other aculties, and it tends to involve a more urgent ressure to produce visible results. President Wilbur irected attention to the recent decision of the anners' Council to place its research project at the University of Cincinnati, the Council having come to the conclusion that "the university atmosphere is the right place for research." This view may be compared with Sir Frank Heath's pronouncement at the May conference of British universities to the effect that modern demands seem to point to the necessity for at least four types of organisation for research: universities, central research institutes, industrial research laboratories run by the industries themselves, and laboratories of individual firms.

Early Science at the Royal Society.

August 17, 1664. The engine to measure refractions was produced, examined and approved of, and Mr. Hooke the inventor of it, appointed to begin at the next meeting to try experiments in it; as also to give a description of this engine to be kept in the Register-book.—Dr. Goddard was desired to describe his instrument with strings and pulleys intended for a hygroscope, and to take notice of the uselessness thereof, as it had been hitherto contrived, and to think upon another way.

1687. Sir John Hoskyns communicated the following receit of one Simeon Pauli for a varnish to coat and preserve dried plants; infuse in spirit of wine the seeds of wormwood; and then dissolve therein as much gum elemi as it will take; and with this varnish cover the plant. This was thought to be a good means to preserve insects from perishing.

August 18, 1670. Mr. Hooke reported to the society, that he had already found so much, as to suspect some parallax of the earth's orb, and conceived, that it would be more sensible half a year after. He said, that by a perpendicular tube he observed the stars, which pass our zenith, at different times of the year, and by noting, whether the same star be at those different times of observation at the same distance from the zenith or not; concerning which he affirmed, that a certain star was then less distant from the zenith than it had been a month before.

August 19, 1680. The subject of filtration and rising of liquors in small pipes was debated. The difficulty of them appeared; viz., first, from the imperfect exhaustion; and secondly, from the uncertainty of the rising of the same liquor in the same pipes at several times.—Dr. King related that he had observed six or seven sorts of animals, a thousand of any of which were less than a globule of blood.

1663. Mr. Hooke gave in a picture of the stones taken out of the heart of the earl of Balcarres. The lord viscount Brouncker promised to get the same done in plaister.

August 20, 1662. Dr. Wallis's written discourse about Dr. Goddard's experiment of weighing glass canes with the cylinders of quicksilver standing in them according to the Torricellian experimt. was delivered in; but because the understanding thereof depended greatly upon the schemes annexed to it, the reading of it was deferred till the next meeting: and the amanuensis was ordered to draw the said schemes in great upon a large paper that every member might look upon them with conveniency.—Mr. Powle to be written to by Mr. Oldenburg, that he would send the society an exact description of the whispering place in the cathedral of Gloucester.

1684. Mr. Henshaw having propounded to try, whether a thermoscope, exhausted of air, with the liquor in it, exhausted of air too, might be sensible of cold and heat, as ordinary thermoscopes are; the thing was tried, and found that the effect was not sensibly altered by the absence of the air.

August 21, 1661. Mr. Colwall read his "Relation concerning the making of Alum," for which he received the thanks of the society, and it was ordered to be registered.

August 22, 1678. Mr. Hooke delivered to the Society an antient urn of glass, taken up in Spittlefields upon digging cellars there, presented by Sir Christopher Wren. There was this remarkable in it, that it seemed to be made after quite another manner than that used by the present workman in that art, it having no place at the bottom thereof; nor any visible sign how it could be held, whilst the lip and handle thereof were joined to the body.

Societies and Academies.

PARIS.

Academy of Sciences, July 16.—M. Guillaume Bigourdan in the chair.—V. **Grignard** and R. **Jenkins**: Mixed organo-aluminium compounds. The iodides of monoethyl- and of di-ethylaluminium. Dry ethyl iodide reacts with aluminium powder in the absence of oxygen, giving a mixture of the compounds $((C_2H_5)_2 . Al I)_2$ and $(C_2H_5 \cdot Al I_2)_2$. Both compounds are spontaneously inflammable in air, and in contact with water give pure ethane.—Jacques **Chapelon**: The representations of an integral number by certain forms with six variables.—Enrico **Bompiani**: The second fundamental form of a surface.—G. **Maneff**: Gravitation and the principle of equality of action and reaction.— — **Lémeray**: General conditions which must be satisfied by a theory of the universe in agreement with general relativity.—E. **Tournier**: A new method of calculating the power of the reciprocating steam engine.—Louis **Roy**: Electromagnetic waves in continuous media in motion.—Maurice **Curie**: The photo-electric effect and temperature.—P. **Lebeau** and Ch. **Bedel**: The estimation of carbon monoxide. The reagent recently proposed by Damiens (cuprous oxide dissolved in concentrated sulphuric acid) for the absorption of carbon monoxide is modified by the addition of β-naphthol. This addition renders the Damiens reagent more stable, and less liable to absorb oxygen.—E. **Kayser** and H. **Delaval**: Radioactivity and nitrogen-fixing organisms.

CAPE TOWN.

Royal Society of South Africa, June 18.—Dr. A. Ogg, president, in the chair.—R. S. **Adamson**: Preliminary note on secondary growth in some Iridaceæ. Three closely allied genera, Nivenia, Witsenia and Klattia, possess woody stems with continued secondary growth. The secondary growth has the same general features as that described for the arborescent Liliaceæ, but these plants differ in two features:—(1) The secondary bundles, or the inner ones, are very close together, often in contact. The radial arrangement of cells is obscured to a large extent. The bundles arise from a number of cambium cells. (2) In old stems the secondary tissues are arranged in zones (annual rings), a feature not previously described for monocotyledons.—Sir Thomas **Muir**: Note on systems of determinants with sets of deleted elements.—J. **Moir**: Colour and chemical constitution, Part XIX., Organic fluorescence.—S. H. **Haughton**: On a skull and partial skeleton of *Mesosuchus browni*, Watson. This paper contains the description of the only known complete skull of *Mesosuchus browni* from the Cynognathus beds of Aliwal North, as well as of the front half of the skeleton. The relationships of the form with Youngina, the Sphenodontia, the Rhynchosauria, the Lizards, Howesia, and the Thallatosauria, are discussed, and it is concluded that Mesosuchus may be placed in a new family, which is called the Mesosuchidæ, and placed in a new sub-order of Diapsid reptiles, the Mesosuchia.—C. W. **Kops**: A South African life table based on the European male population census. (Communicated by Prof. J. P. Dalton.) The life table is based on the census returns of 1918 and 1921, and the deaths during the years 1919–1921. The function graduated is $q_{\bar{x}}$. The graduation was performed by fitting three curves to the data—a quadratic, together with an exponential function for ages 0 to 15, a first degree function, together with an exponential for ages 24 to 108, and these curves are joined by a cubic function having first order contact with each of the other curves. A Makeham graduation was also applied from age 20 to the end of the table. Both graduations are then compared with standard tables from other countries. Graphical comparisons are also made in the case of each graduation.

ROME.

Royal Academy of the Lincei, May 18.—B. **Grassi**: The transmission of malaria. In some years marked discordance exists between the number of Anopheles and the intensity of the malarial epidemic, the number of malarial individuals at the outbreak of the epidemic being insufficient to justify such discordance. The amount of semilunar gametes in some localities appears inadequate to explain the epidemiology of this form of malaria, except on the supposition of a mutation of the tertian parasites or a hybridisation of the latter with the estivo-autumnal parasites. A general incongruity is observed between the abundance of the gametes and the new infections, the gametes abounding particularly in winter and spring during which seasons the Anopheles has no opportunity of undergoing infection.—A. **Russo**: Mixed individuals formed from the ex-conjugants, after true conjugation in *Criptochilum echini* Maupas, and the origin of the gametogens. These mixed individuals are shown to be differently constituted, not only from the diverse origin of the nuclei composing their nuclear apparatus, but also as regards the quantity of nuclear substance present. Of the four nuclei which go to make up this nuclear apparatus, one only assumes the sexual function for the formation of gametes.—G. **Vranceanu**: Stability of rolling of a disc.—M. **Maggini**: Distribution of the radiating power on planetary discs, determined with the interferometer. Investigation of the distribution of luminous intensity on the apparent discs of the planets Uranus and Vesta shows that, as is the case with Jupiter and Saturn, the peripheral regions are less luminous than the central ones.—F. **Signore**: Temperature measurements made in Lake Lucrino and in the neighbourhood of Maricello during 1922–1923.—G. **Piccardi**: Further observations on a thermal method for the study of gaseous systems. Experiments on a number of the more permanent gases by means of the apparatus now described give results in satisfactory agreement with the theory previously advanced.—G. R. **Levi** and A. **Ferrari**: Crystalline lattices of magnesium hydroxide and carbonate. The fundamental element of magnesium hydroxide is a parallelopiped having a rhombic base of side 3·114 Å and an acute angle of 60°, the height being 4·735 Å. The corresponding density would be 2·40, which agrees perfectly with the actual values for the natural and artificial products.—O. **Munerati**: Artificial nocturnal illumination as a means of accelerating the phases of the vegetable cycle.—R. **Perotti** and F. **Aureli**: Ammonifying power of arable soil. The method of measuring the ammonifying power of soils by means of nutrient solutions reveals marked differences corresponding with those found in the condition of the vegetation of the soils. With "normal" soils, which exhibit an alkaline reaction, the aptitude to the micro-biochemical production of ammoniacal nitrogen usually suffices for the needs of vegetation.—R. **Perotti** and G. **Grandis**: Measurement of the nitrifying power of arable soil. The optimum conditions for the measurement of the nitrifying power of soil by the method of nutrient solutions are defined.—P. **Dorello**: Observations on the erectile body of the penis of the genus Helix.—A. **Busacca**: Structure of the living crystalline fibre. The protoplasm of the fibre of the crystalline lens exhibits formations of undoubted mitochondrial character. These formations being mobile, the fundamental substance of this protoplasm is not a solid hydrogel but one of some fluidity, the latter resulting from the high degree of

bibition experienced during the development. though it has undergone very marked differentiation, the protoplasm preserves unchanged all the tributes of true protoplasm and cannot be regarded a metaplasmatic substance.—E. **Momigliano**: Behaviour of lipoids in nephropathy.

Vienna.

Academy of Sciences, March 6.—F. **Reinitzer**: Researches on olive-resin.—R. **Weiss** and E. **Freund**: The action of organic magnesium compounds on phthalonitril, I.—G. **Weissenberger** and L. **Piatti**: The behaviour of creosole towards alcohol, ether, and acetone.—V. **Brehm**: Diagnoses of new Entomostraca, part III. Report from the Handel-Mazetti Expedition to China, 1914–1918, supported by a grant from the Vienna Academy of Science. New species are, *Diaptomus bidens*, Yunnan, and *D. Walterianus*, Yunnan.—G. **Jager**: The lines of force in the special theory of relativity.

March 13.—F. **Feigl** and A. F. **Lederer**: On diphenylcarbazon and its salts, also on the supposed diphenylcarbodiazon.—J. **Krames**: Regular surfaces of the third order, the infinite curves of which doubly osculate the absolute conic section.

March 20.—K. **Mader**: On the use of the Eötvös balance with large masses at close distances.—E. **Müller**: A new method for combined measurements of the capillary constant and of the internal friction of viscous liquids.

April 3.—E. **Heinricher**: Sleeping reactions of the inflorescences of *Dimorphothera pluvialis* (L.). The principal factor in the sleeping reactions of *Dimorphothera pluvialis* is change of temperature.—D. **Pettersson**: On the maximum range of the particles discharged from radium C (Mitt. d. Ra-Inst's No. 163). The long-range particles assumed by Bates and Rogers to be discharged from radium C have been examined under conditions excluding the production of secondary particles. The number of particles of ranges exceeding that of the normal α-particles was found to be less than a few per cent. of the number found by these authors.—E. **Landau**: On the inapplicability of Pfeiffer's method in the analytic theory of numbers.—R. **Weiss** and J. **Korczyn**: (Trimethylene-triphenylmethane-triketon).—A. **Merz**: Investigations of elastic after-effects by an acoustic method.—M. **Eisler** and J. **Portheim**: On insulin-like substances and their action on the exchange of the carbo-hydrates (Preliminary communication). Production of an insulin like substance from seeds of *Phaseolus multiflorus*, and preliminary experiments on the influence of this substance on the exchange of carbo-hydrates in the plants.—I. **Robinsohn**: The colouring of the stigmata—Stigmatochromy. A morphologic-biological method for researches on flowers.—H. **Handel-Mazzetti**: Plantæ novæ Sinenses diagnosibus brevibus descriptæ.—Fuller Abstracts for the Vienna Academy of Sciences in 1923 are given in *Die Naturwissenschaften* for May 9 and May 16, pp. 372 and 394. These contain earlier papers on Triton by Weiss, on meteorology by Exner, and on cave-bears by Abel and others.

May 8.—Alois **Zinke** and Franz **Hanselmeyer**: Researches on perylene and its derivatives (Communication VI).—Alfred **Wagenhofen**: Contributions to our knowledge of para-orsellinic-acids. The aim of the work was the verification of the influence of the methyl-group on the retention of the carboxyl-group in many-substituted benzoic acids, for which the para-orsellinic-acid was chosen as starting-point. The nitrification of the dimethyl-para-orsellinic-acid-methyl-ester led to a mono-nitro-substitution product.—Elisabeth **Kara-Michailova** and Hans **Pettersson**: Communication of the Radium Institute, No. 164. On the measurement of the relative brilliancy of scintillations. A method is described for the determination of the relative brilliancy of scintillations and of their application for a confirmation of the particles deviating from quartz under α-particle bombardment as H-particles.—Anton **Kailan** and Roman **Obogi**: On the question of purifying glycerine from volatile fatty-acids and their esters. The addition of alkali works prejudicially on the distillation of glycerine, since it does not diminish, or does not appreciably diminish, the acid figure in the chief fraction whilst the ester figure is very strongly increased.—Kasimir **Atynski**: The preparation of selenides from selenium hydride and metallic salt solutions. The selenides are appreciably less stable than the sulphides.

May 14.—P. **Flach**: Cytological researches on vessel formation in *Cucurbita Pepo*.—Frau Dr. Helene **Kurz**: *Pholidopus* (*Achtheinus*) *intermedius* and *Dissonus glaber*, two new species of the family Caligidæ.

Washington, D.C.

National Academy of Sciences (Proc. Vol. 10, No. 6, June).—W. M. **Davis**: The formation of the Lesser Antilles. The banks on which the Lesser Antilles stand represent reef-enclosed lagoon floors, formed according to Darwin's theory of coral reefs and modified by the processes of the glacial-control theory. The scheme of development is as follows. First there is eruptive growth of a volcanic island on a subsiding foundation; subsidence continues after growth ceases and lagoon deposits increase within the up-growing barrier reef. Reef abrasion and headland cliffing occur whenever the Glacial period intervenes. The second cycle commences by upheaval or uptilting and may interrupt the first cycle at any stage. Some of the Lesser Antilles are first stage islands and some belong to the second period.—G. R. **Putnam**: Radio fog signals for the protection of navigation; recent progress. The radio compass is considered to be the most important instrument invented for use on shipboard since the introduction of the magnetic compass. It is used in conjunction with radio fog signals which, in the United States, consist of characteristic signals on a wave-length of 1000 metres. There are 11 such beacons in the United States waters and 12 outside. About 291 vessels now have radio-compasses or direction finding apparatus. The spark transmitters are to be replaced by tube transmitters. With the present apparatus and conditions of use, no serious error is caused by the "night" effect.—D. F. **Jones**: Selective fertilisation among the gametes from the same individuals. Pollen carrying a dominant factor is better able to accomplish fertilisation in a sporophyte carrying the same factor than pollen carrying the corresponding recessive factor.—W. E. **Castle**: The Japanese rabbit and gametic purity. The so-called "Japanese" rabbit is yellow, mottled or brindled with black. The brindling seems to depend on the formation of a mosaic type of gene, very rare in occurrence but very stable when once produced, which is due to imperfect segregation between black and yellow, themselves simple allelomorphs.—K. **Sax**: The nature of size inheritance. Experiments with beans show that differences in size and total yield are, to some extent, due to factors linked with qualitative factors which are subject to Mendelian inheritance. Analysing Castle's rabbit data by determining partial correlations with body weight held constant, it is concluded that Castle is correct in stating that the genetic agencies affecting size in rabbits are general in action. The data of other workers using different animals indicate that body proportions may not be entirely dependent on factors which affect body weight.—E. B. **Wilson** and W. J. **Luyten**: A statistical discussion of sets of precise astronomical measurements. II—

Proper motions. Allegheny and McCormick Observatories issue photographic proper motions in Right Ascension with reference to the mean of the comparison stars. The values are compared with meridian circle determinations (Boss), from which it appears probable that a factor of about 1·4 should be applied to the probable errors.—Raymond **Pearl**: The influence of alcohol on duration of life. Accurate information has been collected for a group of more than 6000 white persons of a working-class population. Exhaustive data were obtained and the material classified in eight groups according to alcohol consumption. Calculation of life-tables and so on shows that at every age from 30 to 100, moderate drinkers of both sexes have a slightly *higher* expectation of life than abstainers. Male heavy drinkers have a markedly lower expectation of life than moderate drinkers from 30 to 100 and than abstainers from 30 to 60; from 60 onwards the advantage is slightly to the heavy drinkers, possibly due to the selective effect of high mortality among heavy drinkers prior to 60. For females, expectation of life is markedly lower for heavy drinkers than for moderate drinkers or abstainers from 30 to 100.—W. M. **Wheeler**: Two extraordinary larval Myrmecophiles from Panama. Both were found in ant nests. One is broad, regularly elliptical, 5·7 mm. long, with flattened creeping-sole bordered with minute red papillæ; the integument is smooth, pale blue, and bears regular longitudinal white scales which on pupation were thrown violently off. No imaginal fly was obtained. It has been named *Microdon æolidiformis*. The other form has an anterior portion which can be withdrawn into the carapace-like abdominal region. The latter is covered with a mosaic of regular hexagonal chitinous plates, the dorsal surface bearing regularly arranged sense-organs; there is no creeping-sole. It has been named *Nothomicrodon aztecarum*.—W. B. **Cannon** and A. **Querido**: The rôle of adrenal secretion in the chemical control of body temperature. The rate of heart beat in animals with denervated hearts was increased 12 to 64 per cent. by cooling the body. The effect is not obtained if the adrenal glands are made inactive though shivering is still produced. It is argued that increased adrenal secretion can augment metabolism to counteract the effects of cold.—W. B. **Cannon** and J. R. **Pereira**: Increase of adrenal secretion in fever. Experiments similar to those of the previous paper show that fever is associated with increased adrenal secretion.—E. W. **Brown**: An explanation of the gaps in the distribution of the asteroids according to their periods of vibration. Instability of motion is suggested, on a mathematical basis, as the cause of the gaps.—J. H. **Oort** (1) Note on the difference in velocity between absolutely bright and faint stars. For stars with total velocities less than 65 km. or for stars moving in a direction opposite to the motions of high velocity stars, the average velocities for giants and dwarfs are nearly equal. There is no hint of increase of velocity with decreasing mass. (2) On a possible relation between globular clusters and stars of high velocity. Curves showing the galactic distribution of globular clusters and the antapices of the motions of high velocities alike show marked avoidance of the Milky Way.—W. J. **Luyten**: Note on some statistical consequences of the luminosity law.—W. C. **Rufus**: Atmospheric pulsation of the Cepheid variable, η Aquilæ. Line displacements from different elements and at different levels of the atmosphere of a star have been studied. Generally, compression of the atmosphere occurs after maximum compression of the star as a whole, thus accounting for the retardation of the light maximum. The humps of the velocity-difference curves of the various layers are synchronous with the *Stillstand* of the light curve; the latter appears to be due to a stage of comparat rest in the star's atmosphere.—B. de **Kerékjárt** On parametric representations of continuous surfac —A. H. **Compton** and Y. H. **Woo**: The wave-len of molybdenum Kα rays when scattered by li elements. The secondary radiators used were lithiu boron, carbon, water, sodium, magnesium, and a minium, and in every case, after scattering at abo 125°, an addition to the usual Kα peak, there w another in the position predicted by Compto quantum theory of scattering. With sodium a aluminium, there is perhaps some evidence of tertia scattering in accordance with the theory of Cla Stifler, and Duane.—E. C. **Kemble**: Quantisation space and the relative intensities of the components infra-red absorption bands. Bohr's corresponde principle applied to the evaluation of the intensities lines in the infra-red absorption bands of diatomic ga gives values contrary to experiment in the case of t hydrogen chloride band at 3·5 μ. Better results a obtained by assuming a slight precession of the orbi plane about the lines of the earth's magnetic field. L. **Thompson**: The ballistic (air resistance) functio —W. A. **Setchell**: Ruppia and its environmen factors. Two distinct forms of *Ruppia maritima* were found at Richardson Bay, California. stations subject to tidal conditions, the plants w perennials with long, spirally curved peduncles, a most of the fruits were robust, rounded and only sligh curved without pronounced beak (var. *longipe* Plants growing in shallow pools were annuals wi practically opposite characteristics (var. *rostrat* Laboratory experiments show that both variet tolerate a wide range of salinity, P_H and dayligh darkness ratio; temperatures of 15-20° C. are nec sary for germination, and 20-25° C. for growth a reproductive activity.

Official Publications Received.

Department of Agriculture, Ceylon. Bulletin No. 69: Notes on Habits and Life-History of the Indian Glow-worm (An Enemy of African or Kalutara Snail). By Dr. J. C. Hutson and C. Douglas Aus Pp. 60. (Peradeniya, Ceylon.) 40 cents.

Canada. Department of Mines: Geological Survey. Bulletin No. (Geological Series No. 43): Contributions to Vertebrate Palæontolo By Charles W. Gilmore. Pp. ii+64+12 plates. Memoir 136 (No. Geological Series): Arnprior-Quyon and Maniwaki Areas, Ontario Quebec. By M. E. Wilson. Pp. iii+152+12 plates+4 maps. Mem 137 (No. 118 Geological Series): Palæontology of the Silurian Rock Arisaig, Nova Scotia. By F. H. McLearn. Pp. ii+179+30 pla (Ottawa: F. A. Acland.)

Department of Commerce: U.S. Coast and Geodetic Survey. Se No. 258: Effect of Variations in the assumed Figure of the Earth on Mapping of a large Area. By Walter D. Lambert. (Special Publicati No. 100.) Pp. iii+35. (Washington: Government Printing Office.) 5 ce

Department of the Interior: Bureau of Education. Bulletin, 1 No. 21: Practices and Objectives in Training for Foreign Service; Re of the National Conference on Foreign Service Training, Washingt December 26, 1923. Prepared by Glen Levin Swiggett. Pp. iii+ (Washington: Government Printing Office.) 5 cents.

Annuaire de l'Observatoire Royal de Belgique, 1925. Publié sous direction de G. Lecointe. Pp. vi+294. (Bruxelles: Impr. Van Gomp

Department of Commerce: Bureau of Standards. Circular of Bureau of Standards, No. 101: Physical Properties of Materials. Strengths and related Properties of Metals and Wood. Second editi Pp. 204. (Washington: Government Printing Office.) 40 cents.

Det Kgl. Danske Videnskabernes Selskab. Mathematisk-fysi Meddelelser, V, 3: On the Effect of Magnetic and Electric Fields on Mercury Spectrum. By H. M. Hansen, T. Takamine, and Sven Wer Pp. 40+2 plates. (København: A. F. Høst and Son.) 2.25 kr.

Department of Commerce: Bureau of Standards. Scientific Papers the Bureau of Standards, No. 487: A Quantitative Study of Regenerat by Inductive Feed Back. By C. B. Jolliffe and Miss J. A. Rodm Pp. 419-428. 10 cents. Scientific Papers of the Bureau of Standar No. 488: Thermal Expansion of Molybdenum. By Peter Hidnert W. B. Gero. Pp. 429-444. 10 cents. Technologic Papers of the Bur of Standards, No. 258: Strength of Steel Tubing under combined Colu and Transverse Loading, including Tests of Columns and Beams. Tom W. Greene. Pp. 243-276. 15 cents. (Washington: Governm Printing Office.)

Liverpool Astronomical Society. Annual Report 1923–1924. Pp. (Liverpool: H. Norman Edge, Hon. Sec., Central Technical School.)

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NATURE

SATURDAY, AUGUST 23, 1924.

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON

NO. 2860, VOL. 114]

Problems of the Coal Mining Industry.

WHEN Mr. Lloyd George was in power about 1919, various proposals relating to the mining industry were put forward by him; and it may be remembered that they were rejected successively by all the interested parties. The essential points of these proposals have now been re-stated in a report entitled "Coal and Power,"[1] just issued as a slender volume. We are not concerned here with the political aspect of Mr. Lloyd George's suggestions, but it may be worth while to consider the technical and economic sides. As regards coal mining, the suggestions fall into two main groups, namely :

1. The acquisition by the State of mineral royalties. (Incidentally it may be noted that the authors of the report have not decided how far they should go in this respect; in the introduction, the summary of the proposals suggests "purchase of all minerals and royalties by the State," whereas in the body of the report we find the following sentence : "Further, it is to be considered whether the State, when acquiring its coal resources, should at the same time acquire all the mineral resources of the country." Surely the author or authors of this report ought first to have made up their minds as to what they really want to do.)

2. The formation of consultative bodies consisting of miners and mine owners, who are apparently to discuss the problems of the industry. (Throughout, the author or authors of the report overlook the importance of the mining engineer and the mine manager; whenever the technical staff is casually referred to, it is looked upon as part and parcel of the mine ownership; any discussion of the future of the industry that fails to recognise that there are at least three separate bodies to be considered, namely, miners, mine owners, and technologists, must necessarily be imperfect.)

The report examines at some length the reasons for the present disturbed state of the industry, but fails to recognise one of the most serious. A small but active section of the miners' leaders appears to have determined to get the whole of the coal mining industry into its own hands, an operation which these men designate as nationalisation, and apparently they have come to the conclusion that the best way of attaining their object would be to wreck the industry as it now exists.

It is pointed out quite clearly in the report that nationalisation of the coal resources is a matter which can legitimately be undertaken by the State, whereas the nationalisation of the industry cannot. It is well known that there are two forms of mineral ownership. In one, which is adopted by most Conti-

[1] Coal and Power: the Report of an Enquiry presided over by the Rt. Hon. D. Lloyd George. Pp. xiv+139+16 plates. (London: Hodder and Stoughton, 1924.) 1s. net.

nental nations, the State owns the minerals and leases them to the mine owners; in Great Britain and the United States, the minerals are the property of individuals who may deal with these minerals as they see fit. Both systems operate and operate successfully, but it is a curious fact that the two countries where the minerals are privately owned are those where mining has reached its highest pitch of development, and, incidentally, where the miners' wages are the highest. The present report proposes to purchase the coal royalties, and shows a series of advantages which it claims would result from such change of ownership. Curiously enough, not a word is said about the fact that the Crown already owns quite important mineral areas; for example, it owns all the under-sea coal, and it owns practically all the coal in the Forest of Dean Coalfield. This State-owned coal, however, is leased and dealt with in precisely the same way as the privately-owned coal in the country, and none of the advantages which are claimed for the State ownership of minerals are apparent in the quite considerable tracts of State-owned coal already in existence. Incidentally it may be pointed out that wages in the Forest of Dean coalfield are about the lowest in the whole country.

No reference is made in this report to the very important lessons to be learnt from the United States. In the United States the minerals were originally the property of the State, and at first the Federal Government attempted to lease its minerals, but after something like half a century of experimenting on these lines it was found far better to get the mineral lands as soon as possible into private hands. The author or authors of this report might study with advantage the evidence given by Dr. R. W. Raymond before the 1889 Royal Commission on Mining Royalties upon the methods adopted in the United States. One sentence alone from his evidence may be repeated here: "I have been accustomed to say at home over and over again that it would be better for the United States to-morrow to give up all its mineral land and deliberately convey it to individuals for nothing in order to have somebody own it instead of the Government." In the face of such an emphatic pronouncement, based upon experience, it would surely appear to be a risky experiment to desire to revert in Great Britain to the method of State ownership of royalties. It may be freely admitted that the method is quite workable, seeing that it is in operation in most Continental countries, but there is no evidence that any advantage would accrue from it.

Another point which is emphasised in the report before us is the possibility, if all the minerals were State-owned, of doing away with barriers. Any experienced coal miner knows that some barriers are indispensable for the safety of the mines; the repo also overlooks the fact that power to have unnecessa barriers removed is given under the Mines (Worki Facilities and Support) Act 1923, but so far not single application for the removal of barriers und this Act has yet been made, which shows that the ev if it exists at all, is certainly not a very pressing one

The method suggested for the purchase of royalti is to divide all minerals into three classes, those whic are known to exist and are actually under lease, tho the existence of which is highly probable althoug they are not actually under lease, and those as to th existence of which nothing definite is known. It proposed to deal forthwith only with the first name of these, and that they should be purchased for bon issued by the Treasury, bearing interest, the rate which the report conveniently omits to give. It stated, though no basis of calculation is given, tha the actual value of these minerals is approximatel 70,000,000*l*. The total known coal reserves of Gre Britain have been estimated at something like 150,0 million tons; assuming an average coal output 300 million tons, the coal reserves would give a li of 500 years. For actuarial purposes this may b looked upon as a perpetuity, and the calculation i this way simplified. The amount of royalties pai on coal in 1923 was 6,300,000*l*., so that unles royalty owners are to be deprived of a portion of the income, these bonds ought to bear 9 per cent. interes These points are not considered in the report.

The second suggestion, which again is by no mean fully worked out, is to appoint a series of bodies whic are apparently to take a sort of paternal consultativ interest in the mining industry. It is proposed t have three bodies, a National Mining Council to dea with the industry as a whole, District Boards fo dealing with questions in each individual district and Pit Committees to be "established in connexio with every pit, to consist of equal numbers represent ing the management and the workers." The repor does not make it clear whether "pit" committee i meant or not. There are individual colliery companie having a dozen different pits; is it suggested tha there shall be such a committee for each one of thes pits? The idea of pit committees was decisivel rejected by both the miners and the mine owners and rightly so. The first essential for the safe an economic administration of a colliery is strict disciplin throughout the pit, and it is obvious that there woul be an end of such discipline if every petty questio that arose had to be referred to a pit committee, whil practical men do not need to be told that, in everyda colliery working, problems arise which must be deal with on the spot and cannot be left to stand ove

r discussion in a fortnight's time by the pit committee. istrict boards would probably do no harm, and a ational Mining Council would probably be quite eful. Indeed, something approximating to this ready exists in the Advisory Committee of the Mines epartment.

A detailed discussion of all the statements in this port would demand far more space than is here ailable; the reader not versed in colliery matters ould, however, be warned not to take all that he ds here as gospel truth, an unfairly coloured picture ing presented in many cases, Thus to take e example, a number of photographs of miners' uses are shown, obviously with the intention of citing the reader's sympathy. Three of these are a block of cottages at Leadgate in Co. Durham. a matter of fact, these cottages are now being pulled wn by the colliery company which owns them in der to be replaced by more modern accommodation; rely the writer of the report ought to have known is fact, and if he knew it he ought surely to have ated it! It is difficult to understand how any one o knows the miner at all can write such a sentence this: "Habituated with the conditions he (the iner) is not impressed with the imminence of danger, t he is aware of it; it is at the back of his mind always d affects his outlook on life." The miner rarely thinks danger when he goes to his daily work, and would obably feel deeply insulted if any one suggested to m that he did. A couple of Durham pitmen who had en called up to London to give evidence in conxion with a mining case were heard on their return be congratulating each other on being once again fe down the pit and away from the dangers of the ndon streets, and this represents the true attitude the miner towards his daily occupation. As a matter fact, their estimate of comparative danger was not ally so far off the mark, seeing that there were *two-nd-a-half times* as many fatal accidents (in 1922) in e streets as there were in the collieries of Great itain. Great play is usually made in the discussion coal mining, especially by those who are ignorant the subject, with the dangers supposed to attend is work. It is unquestionably one of the more ngerous occupations, but its dangers are immensely ggerated, and it may be hoped that the above mple statement of fact may help to put the problem its proper perspective.

It need scarcely be said that there is only one real medy for the difficulties with which the coal industry struggling to-day, and that one, being unpalatable, many salutary remedies are, is never mentioned the report. It is summed up in the two words "MORE WORK."

H. LOUIS.

Theories of Growth and Senescence.

The Chemical Basis of Growth and Senescence. By Prof. T. Brailsford Robertson. (Monographs on Experimental Biology.) Pp. viii+389. (Philadelphia and London: J. B. Lippincott Co., 1923.) 12*s.* 6*d.* net.

THE physicist who theorises is more fortunate than the biologist. He may elaborate theoretical considerations for the whole of his life and still be talking sense at the end of it. It is hard for the biologist to theorise for five minutes without talking nonsense. Yet biologists, in spite of all the warnings of the past, find the theoretical impulse irresistible, and sometimes it is useful for them to give way to it. Not that their theories are likely to be true, but that they usually raise such acute opposition on the part of other biologists that the others devise experiments to refute them, and much valuable information is obtained. Not all theories have this salutary effect. Some act as intellectual soporifics providing attractive names, the frequent repetition of which hypnotises the hearers and stops all further inquiry. Of all the words that possess this "virtus dormitiva," there has been none greater than Weismann's "germ plasm." The "germ plasm," so far as we understand it, is a hypothetical substance with magical properties, which exists in living cells and enables them to divide. Some of it is infinitely divisible, and the possessors of this sort are germ cells; some of it resembles ordinary matter in being finitely divisible, and cells that possess this sort are somatic cells. Perhaps this statement is erroneous and the theory is not quite so bad really, but if so the difference is too subtle to have been grasped by its adherents or opponents.

Prof. Robertson's own theories are of the beneficent type just mentioned, but he has the misfortune to be haunted by the germ plasm, and at times the incubus is demoralising. The main theory which he advocates in this book is definite and capable of being put to experimental test. If it does not agree with all the facts, that is not surprising in the present state of knowledge. We may legitimately applaud Prof. Robertson for having found a theory which accounts for any of the facts, without therefore being expected to believe in it or to refrain from criticising it.

The fundamental facts on which the theory is based are, in brief, that the rate of growth of animals and plants follows a logarithmic formula that is the formula for the progress of an autocatalysed chemical reaction. Among the mammalia three growth cycles can be distinguished. Where, as in man, the cycles are definitely separated, the formulæ for each cycle show excellent agreement with the average curves of growth. In

some animals the cycles overlap and the results are therefore not so clear cut. On the assumption that growth is essentially an autocatalysed reaction, or rather that a reaction of this kind regulates its rate of progress, and assuming also that the autocatalyst concerned has certain special properties, the author proceeds to explain a large number of facts concerning differentiation of structure, regeneration, senescence, and so on. Let us first consider the significance of the growth curve itself.

The rate of growth of an organism, measured as increase in mass per unit time, first of all increases and then diminishes, giving a symmetrical S-shaped curve. This curve might be obtained either if we had an autocatalysed monomolecular reaction which came to a stop by the exhaustion of the material undergoing change, or if the reaction was reversible with both forward and backward reaction behaving as monomolecular, while the material supplying the forward reaction was maintained at a constant concentration. The second alternative is the one Prof. Robertson considers most probable, because in most organisms the supply of nutrient material for the cells is kept constant and the growth of animals certainly does not come to a stop at maturity for lack of nourishment. From the chemical point of view, there are two chief criticisms to be made to this theory. In the first place, it appears to be assumed that the reactions concerned in growth are all going on in homogeneous solution ; an assumption that is not at all probable. The materials used for cell synthesis are certainly in aqueous solution, but some at least of the final products are not.

To this criticism Prof. Robertson would probably reply that whatever the nature of other chemical reactions concerned with growth, the particular one he is interested in occurs in homogeneous solution. Indeed, for the purposes of his theory he assumes that the autocatalyst itself, which must be a synthetic product, is diffusible and can pass from the cells to the body fluids, and therefore is likely to be in solution. If this be so, there is a further and more damaging argument to bring up.

All known processes of synthesis of organic cell constituents from organic food materials are processes of "condensation"; they consist in the elimination of the elements of water from between two or more molecules ; and the reverse process is a hydrolysis. According to Prof. Robertson's own statement (p. 14) his autocatalysed reaction is likely to be of this type, because the only reverse reactions that could behave as monomolecular are oxidations and hydrolyses. As the animal body does not synthesise by reduction, the reactions must consist of condensation and hydrolysis respectively. On his view, however, they must go on in aqueous solution. The chief cell constituents, proteins, po saccharides, fats and lipins, can all be shown to be u stable in the presence of water at the reaction of livi tissues. The position of equilibrium is one of almo complete hydrolysis ; this can be demonstrated by t action of the common hydrolysing enzymes. The fore, cell synthesis must either take place in a no aqueous medium, or else by some process not rep ducible in the laboratory that carries a reaction aw from the equilibrium position, against the therm dynamic gradient as it were. In either case the sim laws of catalysis in homogeneous solution are n applicable.

It is possible to imagine some soluble diffusi material being produced as a by-product of c synthesis and acting as a catalyst of further synthes but it is almost impossible to see how such a substa could control the rate of growth in the way that Pr Robertson supposes. What plausibility his hypothe possesses at first sight, vanishes when any atten is made to describe in detail from the physi point of view how an autocatalyst of growth wo operate.

The autocatalyst of growth is supposed to be pres in the body fluids, and its concentration there is s posed, among other factors, to regulate the rate growth, accelerating it at first, and later, as it accur lates, bringing growth to an end. If this be the case, th blood from an adult animal ought to stop the grow of the tissues of a growing animal, and repeated bleed of an adult animal with replacement of the blood washed blood corpuscles in a suitable artificial medi might be expected to start growth again. Rec experiments by Carrel and Ebeling (*C.R. Soc. Bi* 1924, vol. 90, p. 170) suggest that the blood of you and of old animals differs in some such way, thou the results are not exactly what Prof. Robertso theory would lead us to expect. Moreover, if the the is correct, it must be supposed that the placen membranes alone among tissues are impermeable the autocatalyst, otherwise the mammalian emb would never grow.

The evidence that the autocatalyst is soluble a diffusible is based, not upon any evidence from t higher animals, but solely on studies of infuso bacteria, and yeasts. In cultivating these organis it has frequently been observed that multiplication stimulated by some dissolved substance which resu from the presence of other organisms. (It is a p that in this connexion Prof. Robertson makes reference to the important work of Dr. E. J. Allen the growth of marine algæ (Jour. Marine Biol. Asso vol. 10, 1914, p. 417).) The growth-stimulating su stance appears to be common to several different typ

organism, but it is rather rash to assume on his account alone that an exact parallel can be drawn between the culture medium in which infusion organisms live and the body fluids of the higher animals.

There is no direct evidence on this point as to the higher animals, but some indirect evidence that goes strongly against this assumption. In their powers of chemical synthesis, living things seem to fall into three well-marked groups—the green plants, the "infusion organisms," and the higher animals. At the one extreme the green plants can synthesise all their body material from inorganic sources; at the other the higher animals, who have specialised in a different direction, have very largely delegated the business of synthetic organic chemistry to humbler creatures on whom they feed. The mammalia, for example, cannot synthesise the benzene or indole ring, but have to get them ready made in their food. The infusion organisms, such as yeasts, ciliate protozoa, and probably bacteria, moulds and other saprophytic plants, occupy an intermediate position rather nearer to the green plants than to the higher animals. They cannot live without ready formed organic material, as the green plants can, but they only need comparatively simple carbon compounds. Ciliate protozoa, as Prof. R. A. Peters has shown, besides inorganic salts, need only ammonia and an organic substance, such as lactic acid or glycerol, with a chain of three carbon atoms (*Jour. Physiol.*, vol. 55, 1921, p. 1). When the chemical processes underlying processes of growth are so different in the two groups, sweeping analogies appear to be out of place.

Prof. Robertson embodies in his theory certain subsidiary hypotheses, namely: (1) That growth is regulated by the cell nucleus in which the autocatalyst is found; (2) that it is only during mitosis that the autocatalyst escapes into the cytoplasm and body fluids; (3) that, in any given cell, division is regulated by the relative volumes of nucleus and cytoplasm; (4) that in the life-history of somatic cells there is a progressive change, a process of senescence, whereby the nuclear-cytoplasmic ratio at which division can take place gets smaller and smaller. The last change is supposed to be irreversible, and it is there that the trail of the germ plasm becomes evident. These hypotheses are, to say the least, not very firmly grounded on fact, and it is doubtful whether they increase or diminish the plausibility of the theory as a whole. They do, however, enable the author to give a detailed, if fanciful, explanation of the process of senescence and of phenomena such as the growth of cancer cells.

Leaving these questions aside, let us consider how the author deals with the facts of regeneration of lost or injured parts, for they are likely to prove crucial for any theory which partakes of Weismannism. Although there is considerable discussion about regeneration in the book, it is not easy to find a precise statement as to how the process is supposed to come about, but we get some information on p. 264. The view apparently is that in the adult organism cell division stops because of the accumulation of autocatalyst, but the stoppage is only relative to a given concentration of nutrient materials, so that anything which raises the concentration of nutrient material may start cell division going again. Injury is supposed, by removing competing cells, to cause a local increase of nutrient material, which acts as the stimulus for proliferation. Once the cells have started dividing, the rest of the process is explained in terms of nuclear-cytoplasmic ratios.

This part of the question need not concern us at present, except to point out that regeneration must, on Prof. Robertson's theory, be an irreversible process of senescence and therefore not capable of indefinite repetition. The really startling part of the theory is the suggestion that it is a local increase of nutrient material which first stimulates growth after injury. It must be confessed that no alternative theory is forthcoming, but one is not compelled to accept a false theory because there is no other to put in its place. When a lizard drops its tail there cannot be more than a momentary increase in the nutrient materials in the blood and body fluids, and what increase there may be will be quickly equalised all over the body. Suppose there is an increase that provides the stimulus to cell division, why does growth take place only at the stump and not throughout the whole of the animal?

The regeneration of a lost part is not the result of simple division of the functional cells *in situ*, but is the work of special cells which are in appearance embryonic. These cells appear to arise by de-differentiation of some of the cells of the region of growth. Thus it is found that the lizard's tail is regenerated by embryonic cells in the stump which persist at the growing end, until a tail which is functionally equivalent to the original has been produced. But structurally the new tail is not altogether similar. Bone is not regenerated, but cartilage takes its place and there are no new nerve cells. The new tail is innervated by nerve fibres growing out from some of the intact segments of the spinal cord. (See Dr. C. Powell White, British Assoc. Report, 1915, p. 472; more detailed information is in course of publication by the same author.) Another fact to be kept in mind is that many of the invertebrates can regenerate lost parts an indefinite number of times.

These facts show that the ordinary progression from youth to age can be reversed under certain conditions by some of the somatic cells. Immortality and rejuvenation are not a prerogative of the germ cells only. Somatic cells can, in many cases, take on the functions of germ cells by giving up their special function and reverting to a younger type. This fact has been notorious among the green plants, but it is also evident among the animals, even among the vertebrates. Any remnant of the germ plasm theory, however attenuated, is directly contradicted by these facts. One seems to be driven to take up some sort of position akin to Prof. C. M. Child's, who considers growth, senescence, and rejuvenescence in terms of the metabolic activity of the cells and not in terms of their visible structure or of hypothetical invisible components. One of the defects of Prof. Robertson's book is that he never once mentions Child's theory though referring several times to Child's experiments. In politics it may be often advisable to treat opponents with silent contempt, but men of science are expected to demonstrate the falsity of other theories before establishing their own.

Unworkable as Prof. Robertson's theory is in its present state, it has the merit of emphasising certain important facts which have got to be explained somehow or other. Apart from germ plasm complications, which are really extraneous to the main part of his views, the definiteness of the theory that makes it possible to subject it to experimental test is a great merit.

There is one final point of criticism that is perhaps worth making, though it concerns something outside the author's main line of argument. In the final chapter, in which general questions of evolution are discussed, the statement that variation always takes place by loss of characters reappears once again. It is quite true that under domestication the vast majority of heritable variations that have been observed, both in animals and plants, consist of the loss of a Mendelian factor. But it is also true that the conditions of domestication are physiologically peculiar and that the observed variations do not resemble the type of difference that normally distinguishes wild species from one another. Finally, there are a few cases among domestic animals that cannot be attributed to any cause other than the gain of a Mendelian factor: the most familiar of these are the White Leghorn plumage, and the Rose and Pea Comb among fowls. These are all dominant to the wild type, which in this species can be identified. That variation by gain of Mendelian factors occurs but rarely is no reason for denying its existence.

A. D. R.

Rockets to reach Planetary Space.

Die Rakete zu den Planetenräumen. Von Herman Oberth. Pp. 92+2 Tafeln. (München und Berlin: R. Oldenbourg, 1923.) 1*s.* 6*d.*

THE prospect of propelling a body from our earth to one of the heavenly bodies, notably the moon, has excited certain types of individuals for some time, and many romances have been built up round the idea. Scientific attention has been given to the matter in recent years, and in particular Prof. Goddard of Clark University, in the United States, has examined the question theoretically and experimentally. His plan is to send a rocket to the moon, more or less as suggested by Jules Verne, with the important difference that the rocket is not to be left to the mercies of air resistance and gravitational forces, but is to be propelled continuously by means of firing successive charges of smokeless nitrocellulose. Herr Oberth claims to have obtained the results given in the present volume quite independently of Prof. Goddard. He says that he commenced working at the problem in 1907, and that the main ideas were evolved in 1909; the calculations and proposals of this book were made during the years 1920–22.

Herr Oberth is more ambitious than Prof. Goddard; his object is to obtain sufficient financial support to be able to send off a rocket large enough to hold human beings. For fuel he suggests liquid hydrogen and a mixture of water and alcohol, the liberated gases escaping through small holes at the back of the rocket and thus forcing the rocket forwards. He calculates that an initial speed of 11 km./sec. would suffice for getting out of the earth's field of gravitation. The calculations are simplified by introducing the assumption that while the rocket is still in the earth's atmosphere, the fuel is used at such a rate as to give at each instant what is practically the "limiting velocity" at the instant.

The author discusses the theoretical as well as the chemical, physical, and even physiological aspects of such a venture. He examines the economic possibilities, but he does not appear to be very sanguine about his scheme being carried out. He estimates that a rocket for two persons would weigh 400 tons, would need 25 tons of alcohol and 4 tons of liquid hydrogen and would require an initial outlay of 50,000*l.* on the basis of pre-War prices.

A voyage to the moon would be an attractive trip to many adventurous spirits; and in these days of unprecedented achievements one cannot venture to suggest that even Herr Oberth's ambitious scheme may not be realised before the human race is extinct.

S. B.

Our Bookshelf.

Handbuch der Zoologie: eine Naturgeschichte der Stämme des Tierreiches. Begründet von Prof. Dr. Willy Kükenthal. Herausgegeben von Dr. Thilo Krumbach. Band 1: Protozoa, Porifera, Coelenterata, Mesozoa. Lieferung 2. Pp. 193-416. 10.50 marks. Lieferung 3. Pp. 417-512. 4.50 marks. (Berlin und Leipzig: Walther de Gruyter und Co., 1923–1924.)

PROF. M. HARTMANN, who is responsible for the account of the Sporozoa, has separated the Amœbosporidia (Neosporidia)—with its two subclasses Cnidosporidia and Acnidosporidia—as one of the six main classes of Protozoa, so that the class Sporozoa now includes only the Gregarinida, Coccidia, and Hæmosporidia. The morphology and life history of the principal members of these orders are carefully described, an outline classification showing the position of the chief genera is given, and a list of the more important memoirs on the subject is appended. The value of the many excellent figures would have been enhanced if the magnifications had been indicated; without these the student is apt to form an exaggerated idea of the size of many of these organisms.

The Ciliophora and the Suctoria are described by Prof. L. Rhumbler.

Prof. E. Hentschel contributes the chapter on Porifera, treated in five orders—Calcarea, Triaxonida (Hexactinellida), Tetraxonida, Cornacuspongia, and Lendroceratida. To compress the account of this large phylum into 100 pages necessitates strict selection of the material available, and no two authors would agree as to the matters to be included, but we would suggest that in the account of reproduction, reference should have been made to the observations of Dendy and Gatenby on the origin of oogonia from collar cells in Clantia, and to Gatenby's account of the peculiar method of transportation of the sperm to the egg.

The third Lieferung is devoted to accounts of the Hydroida and Trachylina by Dr. Hj. Broch and of the Siphonophora (part only) by Dr. Fanny Moser. Dr. Broch gives two maps showing respectively the distribution of some of the marine hydroids and of the Trachylina and freshwater medusæ. The occurrence of Limnocnida in India is not noted here or in the text, though reference is given in the literature list to Annandale's papers on this medusa.

The "Handbuch" is trustworthy, clear, and orderly in its method, and is adequately illustrated with good figures. It provides sound information on the morphology, systematics, development, and ecology; histology, however, is only briefly considered.

The Brain and Golf: Some Hints for Golfers from Modern Mental Science. By C. W. Bailey; and a chapter on Theory and Practice by Bernard Darwin. Pp. xv+96. (London: Mills and Boon, Ltd., 1924.) 2*s.* 6*d.* net.

THE theories of a science often appear to students quite intelligible until it becomes necessary to express them in terms of practical problems; the question of application is always difficult no less in science than in ethics. This little book comes as a welcome relief from the wearisome mass of ill-assorted oddments frequently dignified by the name of applied psychology. It is an amusing, light-hearted account of the laws of physiology and pyschology in so far as they apply to the playing of golf. The game is treated with serious humour; the psychology is not merely appended but is used to explain, to illustrate, to vitalise, the game. The psychologist familiar with the principles and accustomed to applying them in certain fields will find them vivified by their new setting. The golfer will find reasons for many inexplicable troubles and will be taught why such and such a habit is desirable or otherwise; he will be saved much unnecessary depression if he really grasps the laws of habit as here explained, and in particular the reference to the "plateau of habit."

The writer might with advantage have invoked still further the aid of the newer psychology and discussed types of golfers as illustrated by Jung's psychological types, and the revelation that is made of the golfer's own character by his behaviour to superiors, equals, and inferiors on the links. The various "complexes" concerned with the "ego" are more evident than the writer shows, for it is in games that people usually display their fundamental characteristics. A writer of Mr. Bailey's capacity might make a fascinating study of this aspect.

The book can be heartily recommended to all intelligent golfers, to students of psychology, and above all, to those concerned with the application of psychology to education.

A Bibliography of Eugenics. By Prof. Samuel J. Holmes. (University of California Publications in Zoology, vol. 25.) Pp. iv+514. (Berkeley, Cal.: University of California Press, 1924.) 5 dollars.

THE literature of eugenics has grown in a most haphazard way. While the number of scientific journals primarily devoted to the subject is a limited one, yet the medical journals teem with papers having a eugenical bearing, and a widely scattered multitude of books and journals contain information biological, anthropological, psychological, and sociological, which the eugenist must needs consider. There has also been a great amount of popular and semi-popular writing on this subject from widely differing points of view.

It is obviously impracticable to bring an index of all this literature within the covers of one volume. Prof. Holmes has attempted the somewhat more limited task of producing a bibliography which would include all the main sources and items of eugenical literature. In doing so he has produced a volume which will be of great service, not only to students of eugenics but also to all who are concerned with the biological evolution of man. That the field is a modern one is shown by the fact that the great majority of the titles are dated later than 1900, and very few are so early as 1860.

The bibliography is arranged under about 40 different headings, ranging through such topics as heredity and evolution, genealogy, inheritance of deafness, the hereditary factor in crime, the birth rate, the racial influence of religion, the sex ratio, consanguinity, and the selective influence of war. Titles on the inheritance of feeble-mindedness occupy 12 pages of the bibliography. One would like to have seen extended

the sections on the heredity of human traits and human defects. Many additions might have been made here even without encroaching on the medical literature. But although completeness is obviously impossible, and the topics of the author's special interest are naturally emphasised, yet this work will occupy a useful place as a first book of reference on any topic connected with eugenics.

The Road-Books and Itineraries of Great Britain, 1570 to 1850: a Catalogue with an Introduction and a Bibliography. By Sir Herbert George Fordham. Pp. xvi+72. (Cambridge: At the University Press, 1924.) 7*s.* 6*d.* net.

ROAD-BOOKS and itineraries are dear to the heart of the collector, but, unlike most collectors' books, they have a wider interest, and their value to the antiquarian and the topographer is considerable. Many, however, and especially the earlier, are rare and difficult to obtain, and Sir H. G. Fordham's bibliography, which is a revised and amplified reprint of a paper published in the Transactions of the Bibliographical Society in 1916, will be of considerable assistance to those who wish to make use of the material to be found in these guide-books of our ancestors. In this catalogue, road-books are taken to include only such as set out individual roads, with distances and stages all grouped together as a book or atlas, and prepared for the use of travellers. They may vary from a mere enumeration of stages to a full descriptive text. The earliest entry is John Leland's Itinerary published in or about 1535–1543. In the later part of the sixteenth century tables of the principal British highways based on the old British mile of 1500 Roman paces, equivalent to 2428 statute yards, were associated with lists of fairs for commercial purposes. Tables of highways of a similar type were published by Charles Etienne in 1552, while in Germany the earliest would appear to be a publication of 1597, containing 187 roads on the Continent and eleven from London to various parts of England and Wales.

Principles of Electroplating and Electroforming (Electrotyping). By William Blum and George B. Hogaboom. Pp. xii+356. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 20*s.* net.

THE work under notice has been written mainly to help those employed in the industry to understand and apply results which have been obtained in research laboratories. The authors have taken a leading part in the investigation of electrotyping and electroplating processes at the U.S. Bureau of Standards. They divide electrodeposition into four main fields: Electrorefining, electrowinning, electroplating, and electroforming. The last is a new word and is defined as "the production or reproduction of articles by electrodeposition." It is suggested as a substitute for the archaic word "galvanoplasty" which is still sometimes found in text-books.

The very extensive use of iron and steel for constructional purposes, and the fact that they rust when exposed to air, has led to numerous investigations as to the causes and methods of preventing corrosion. Many of the investigations were carried out during the War and the general results obtained were summarised in Circular 80 of the Bureau of Standards. It appears that of all commercial metallic coatings, zinc is much th best protector. It is very desirable that zinc platin should be applied much more extensively in industr than it is at present. Unfortunately zinc coatings hav not a pleasing appearance. When a bright metall lustre is essential, nickel is superior to any other materia This book contains a great many valuable hints and ca be recommended to those technically interested in th subject.

The Growth of Civilization. By W. J. Perry. P viii+224+8 maps. (London: Methuen and Co Ltd., 1924.) 6*s.* net.

IN this volume Mr. Perry restates in a more popul and abbreviated form the arguments put forward at length in his earlier works, "The Megalithic Cultu of Indonesia" and "The Children of the Sun," f the diffusion of culture from one common centr namely Egypt. It forms a companion volume to h book on "The Origin of Magic and Religion," whic indeed is essential for the complete grasp of the arg ment here stated, as in the latter he expounded th theory of the magical influence of gold and oth substances which supplied the motive for the wande ings of the people by whom the "archaic culture was carried to various parts of the world. This boo is, however, not merely a condensation of earlier wor It embodies much evidence not previously considere especially in the later chapters, in which he dea with the coming of the warriors by whom the archa civilisation was overthrown in various parts the world, and discusses the theory that traditio of royal descent from deities derive from contact wi Mediterranean culture and ultimately from Egyp Mr. Perry's statement of what is undoubtedly difficult and highly controversial case, leaves little be desired in point of lucidity.

Faune de France. 7: *Pycnogonides.* Par Prof. E.-L Bouvier. (Fédération française des Sociétés Sciences naturelles: Office central de Faunistiqu Pp. 70. (Paris: Paul Lechevalier, 1923.) 8 franc

PROF. BOUVIER points out in his introduction that th pycnogonids of the French fauna have never be studied in systematic fashion. There are memoirs b Hoek on the species found at Roscoff, by Grube on tho of S. Malo, and a recent account by Cuénot of h observations on pycnogonids at Arcachon. The auth has turned to G. O. Sars' well-known monograph an to that of Dohrn for further information, and from the and from Hoek's work he has borrowed most of th figures used in the present volume. He gives an accou of the external morphology, the internal anatomy, an the development and biology, and in a brief discussi of the affinities states his view that the pycnogonids a arachnids. In a short reference to the forms with fi pairs of legs, *e.g.* Decalopoda, he concludes that the are primitive relatively to Colossendeis. Keys are giv for the orders, families, genera, and species, and wi the help of these and the clear illustrations the dete mination of any given specimen is fairly easy. Th concise memoir will be very useful to collectors on t shores of Great Britain who have an interest in th group.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

The Mass Spectra of Zirconium and some other Elements.

AFTER repeated failures I have now succeeded in observing the mass rays of zirconium. Their detection is only possible under very favourable conditions with the most sensitive schumannised plates. Zirconium gives mass lines 90, 92, 94 and a doubtful one at (96), with relative intensities, very roughly, 10, 2, 4, (1) respectively. The masses of the first three can be determined with unusually high accuracy, owing to the incidental presence among them of a faint doublet 93, 95 due to CBr. There is no appearance of asymmetry in the spacing, so that the masses of the isotopes of zirconium must be very closely integral with those of bromine; that is to say, less than whole numbers by about one-tenth of a unit. The atomic weight may therefore be roughly estimated as 91·4 or 91·2, according to whether the mass number 96 is included as an isotope or not.

Successful mass spectra have been obtained with cerium (at. wt. 140·25), which indicate that it consists of a strong component 140 and a weak companion 142. Further experiments with neodymium (at. wt. 144·27) establish its principal isotopes as 142, 144, 146, with a possible (145).

Continuous work with anode mixtures not containing iodide has reduced the intensity of the iodine line sufficiently to warrant a further search for light isotopes of barium. Its principal line 138 has been obtained of great intensity, but there is no trace whatever of any mass number less than 136. There is some evidence of a faint component at 136, and, since the great intensity of the 138 line makes resolution impossible, 137 may also be present. It seems quite certain, however, that, even if both exist, they can only do so in quantity quite inadequate to account for the low value of the atomic weight (137·37) at present in use.

Incidentally, during this work I have obtained mass spectra of silicon under conditions affording satisfactory confirmation of the presence of Si^{30}, previously in some doubt. Its line is a little less intense than that of Si^{29}, in excellent agreement with Mulliken's observations on band spectra (NATURE, March 22 and April 5, pp. 423, 489).

It will be noticed that the above results are on the whole in fair agreement with the predictions made by A. S. Russell. F. W. ASTON.

Cavendish Laboratory, Cambridge,
August 8.

The Zeeman Effect in Strong Magnetic Fields.

IN a recent paper (Proc. Roy. Soc. A, vol. 105, p. 691, 1924), one of us has given an account of a method for the production of intense magnetic fields, with the limitation, however, that the field only lasts for a time of the order of 1/100th sec. We are now investigating the Zeeman effect in these intense fields. These fields allow the use of a quartz spectrograph in place of the usual large concave grating or interferometer, etc.

For the source of light, we have been using a spark produced in a special way from a large high tension condenser battery, and the intensity is sufficient for one spark to produce a spectrum photograph, while most of the emission lines remain quite sharp. The spark takes place in a coil of 5 mm. internal diameter in which the field is produced, and the spark and the current in the coil are timed to occur together.

We have so far investigated mainly the "longitudinal" Zeeman effect (observation in the direction of the lines of force) in fields of about 130,000 gauss as being technically easier than the "transverse" effect. The accompanying photograph (Fig. 1), enlarged from the original six times, shows one of the results. The lines are the first members of the principal series of doublets of ionised calcium (Ca II) and of the sharp series of doublets of aluminium. It is feared, however, that the latter may not show clearly in the reproduction, though they are quite obvious in the original. The magnetic separation is about 3 Å.U.

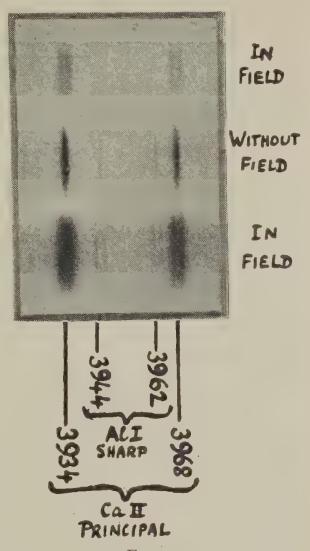

FIG. 1.

Generally speaking, the results so far obtained on lines of various elements indicate that the magnetic splitting is, except for the larger scale, identical with that obtained in ordinary cases. We have, however, observed some interesting cases of the Paschen-Back effect, partial and complete. We may mention in particular the case of the Be group 2650, given by Paschen-Götze as the *p*, *p'* group of Be, and as consisting of six extremely close lines. We have found that this group taken as a whole shows the normal Zeeman effect.

We have observed some interesting cases of lines appearing strongly in the spectrum taken in the field which do not appear in the comparison spectrum, and other cases of lines disappearing in the field. A further effect observed is that the lines produced in the field are shifted towards the red by varying amounts. It is possible that this is a kind of pressure effect, due to the production of the spark in the field, and to investigate the matter further, and for other reasons, we hope shortly to deal with absorption spectra. We have also a project for the production of still higher fields (probably up to 250,000 gauss) by cooling the coil with liquid air in order to be able to use more turns in a coil of given resistance.

P. KAPITZA.
H. W. B. SKINNER.

Cavendish Laboratory, Cambridge,
July 20.

Biology and Sociology.

I SHOULD like to direct attention to a point connected with the above topic which Dr. Malinowski does not mention in his article in NATURE, July 19.

What is of importance is not the transference of ready-made biological theories to the field of sociology, but rather that the problems of cultural evolution should be approached from the same detached and objective point of view as that of the biologist. Natural selection, for example, can be strictly said to operate

in the latter case only where competition may result in the extinction rather than the modification of whole groups, where, alone, a particular cultural element has a definite survival value in the biological sense. But it is none the less true that the process of what may be termed "bio-economic adjustment" is still everywhere proceeding, and the character of the culture-milieu of a particular society at any moment must be regarded, in the main, as a reflex of the whole complex of primary and secondary environmental factors which operate upon the group-members, in addition, usually, to a number of functionless or residual characters of historical interest, which were evolved in relation to anterior conditions.

Perhaps the most important lesson that sociology can learn from biology is the fundamental distinction between the purely *historical* problem in evolution and the question of the *machinery of variation*, a distinction which, in sociology, is unfortunately often disregarded. We desire to know, not only what has happened, but also how it happened, and why it happened only in this particular time and circumstance. It is too often tacitly assumed, especially by the "new" anthropologists, that to point out a possible derivative origin of a certain cultural element is a sufficient explanation of its existence in a particular society. The conditions which govern *assimilation* are of equal if not greater importance. To give a homely example: if Dr. Malinowski were to appear in his class-room wearing a Malayan kris, this would introduce a new cultural element into British academic life; but it is very doubtful if it would afford any research problem for the future historical sociologist.

Moreover, just as in biology the problem of variation is being most usefully attacked by concentrating upon small definite changes in organic characters, which are actually taking place now under observational conditions, rather than upon the historical background of evolution: so we must hope to make most progress in the study of cultural variation by observing and correlating small specific changes in contemporary civilisation, rather than the character of past or primitive societies. It is more useful to analyse carefully the conditions which are associated with the incidence of prohibition or divorce reform than to speculate about the origin of totemism.

To contrast the instinctive and physiological dispositions of an insect colony with the "culture" of human society does not take us very far, unless we have a clear understanding of the factors upon which cultural changes depend. This latter question cannot be discussed here, but it may be pointed out that whereas the *limiting conditions* of social changes are bio-economic, the machinery of variation is psychological. The psychological factors involved are partly rational, but mainly in the nature of specific emotional dispositions in relation to particular social facts. Dr. Malinowski's suggestion that these definite but variable ethical and æsthetic attitudes are due to the secondary modification of primary instincts does not help very much. To say, for example, that humanitarian sentiment is a secondary derivative of the parental instinct does not explain why the *average* emotional reaction of successive generations of the same society towards specific questions (*e.g.* slavery, criminal punishment) should often be so markedly different. From the point of view of cultural evolution, it is the exact character, sequence, and correlations of these specific reactions which is of principal importance.

C. W. SOAL.

Scratton Lodge, Prittlewell, Essex.

IN the article referred to by Mr. Soal, I have tried, on a parallel between an insect aggregate and human society, to trace the breach of continuity between biology and the science of human culture, as w as to establish their points of contact. I have al criticised certain illegitimate attempts at transferen of methods and concepts from the study of livi organisms to that of culture and social organisatio notably the society-organism simile, the theory "herd instinct," and certain crude applications Darwinism in sociology. In the above letter it suggested, obviously in criticism of the last-mentione contention of mine, that I have neglected to discu the applicability of natural selection to the study human culture.

It is now a commonplace for any competer sociologist that natural selection, as we know it fro biology, cannot in any way operate on human i individuals within the community—and this is mac clear to any one who reads my above-mentione article. Nor can the principle be applied to an struggle or competition of groups within society. (F searching criticism, see J. Novicow, "La Critique d Darwinisme sociale," Paris, 1910, and III. Abteilun "Die allgemeine biologische Soziologie," in P. Barth "Die Philosophie der Geschichte als Soziologie," p 260-437, 4th ed., 1922.)

But there remains the question: Can natur selection or Darwinism in general be applied t varieties of the human species, to races, or to enti populations, or to types of human culture taken as whole? Here also there is no new ground to breal for the "struggle of races" (Rassenkampf) has bee used, abused, and rejected as a leading principle social science, while laws of growth, culmination, an decay of nations and cultures have been constructe and demolished more than once. Again, what coul be called "the struggle of cultures," the contac mixture, and transmission of whole types of civilisa tion or elements thereof, is really the fundamenta principle of the "new anthropology" mentioned b the above correspondent. How far the adherents c this school will succeed in explaining everything b this principle, or in constructing a new theory c universal advance by contact of cultures, remains t be seen. At present they are clearing the ground amassing material, and working out particular ques tions.

Thus the problem which Mr. Soal recommends *e passant* to the attention of anthropologists is, as matter of fact, the fundamental problem of the scienc of man, inspiring all the general theories and enterin into all detailed work on concrete subjects. It is of course, recognised to be so by all anthropologist who reflect on the aims of their science. So tha generalities such as that "natural selection . . . ca be strictly said to operate . . . where competitio may result in the extinction rather than th modification of whole groups"; and again, abou "bio-economic adjustment" or about "a reflex o the whole complex of primary and secondary en vironmental factors which operate on all the grou members," etc., will be of little use even to those who can grasp their somewhat cryptic meaning.

I think it is obvious that in this connexion biology cannot help us very much, for natural selection, as we see it at work in the world of plants and animals, cannot be applied to the study of societies. Natural selection operates on individual organisms, directly at grips with their environment, competing with other creatures who need the same food, every individual struggling by its own efforts, pursuing its own ends, and having to rely on its own anatomical and physiological endowment. A human society is not an individual organism; it possesses no anatomical or physiological equipment, it has no biological aim or needs of its own. It exists only by its own members and for their benefit. The type, the aim, and the

lue of its organisation and culture must be gauged
the manner in which it ministers to the wants of
e individuals which constitute it. Here then are
oblems so absolutely foreign to the biological theory
natural selection as to preclude any borrowing by
ciology from biology.

Mr. Soal's kind exhortation to anthropology that
should become "detached and objective," and that
should give up troubling about the "character of
ist or primitive societies," and study "prohibi-
on or divorce reform" instead, will no doubt be
mbly and hopefully received by other anthropolo-
sts as it is by the present writer; though I fear
at my experience in discussions about problems
uching liquor and sex seems to show that they do
t lead to an "objective or detached" frame of mind.
the attempt to follow his advice, we might realise
r. Soal's "homely example" of an anthropologist
ppearing "in his class-room wearing a Malayan
is," a tendency of which he seems to suspect me.
do not think there is any hope, either, that the
ience of primitive man should give up studying
imitive man, any more than that astronomers should
ve up studying stars, when advised to turn their
tention to turnips and potatoes, since this "is more
eful."

BRONISLAW MALINOWSKI.

Department of Ethnology,
London School of Economics,
University of London.

Solubility of Phosphates in Relation to Hydrogen Ion Concentration.

WITHIN the last few years statements have appeared
various journals giving the P_H values at which
rtain salts yield precipitates upon being rendered
ss acid. Some of these also record the lower limit
acidity at which precipitation is said to be com-
lete. It accordingly appeared to be of interest to
etermine the form of the solubility curve. This
as done for certain phosphates, using samples
rchased as pure and washed with distilled water
peatedly to remove traces of more soluble phos-
hates, etc. The determinations were made at air
mperature, about 10-12° C., upon solutions cleared
y the centrifuge, using the cœruleo-molybdate
action of Denigès. Nine determinations were
ade upon a sample of tricalcic phosphate (B.P.),
etween P_H7·0 and P_H5·1, hydrochloric acid being
ed to increase the acidity.

Over this range the solubility increased from 114
786 parts per million. When P_H values are taken
ordinates (the higher values being at the bottom of
e paper) and concentrations as abscissæ, the nine
ints give a curve which at first ascends steeply and
en becomes more nearly parallel to the concentra-
on axis; thus a small change in the P_H value is
companied by a large change in solubility. Accord-
gly the precise P_H value at which a precipitate is
rst obtained depends on the concentration of the
hosphate and precipitation is never absolutely com-
lete with the pure salt, even at P_H7·0. The phos-
hates of strontium and of barium give curves which
e qualitatively similar. The phosphate of mag-
esium is more soluble 450 p.p.m. at P_H7·7, and the
rve rises somewhat less sharply at the start; it
aches the value 1233 p.p.m. at P_H5·8.

$CaHPO_4$ is much more soluble than $Ca_3(PO_4)_2$, and
e solubility of the latter is increased if it contain
ny of the former as an impurity. $CaH_4(PO_4)_2$ was
und to dissolve readily, a slight deposit only being
ft; this does not appear to be the original salt.
he reaction given by the sample used was markedly
id, P_H3·6.

The phosphates of lead and zinc were found to be highly insoluble, lead only giving phosphate equivalent to 0·97 p.p.m. of P_2O_5 at P_H6·75 and zinc 1·11 at P_H6·85, nickel follows with 11·9 at P_H8·9. The readily hydrolysed ferrous and ferric phosphates appear to have solubility minima in the acid region, and the addition of alkali to bring the solutions to neutrality results in more phosphate becoming available in solution. These relations, being of importance in studies on plant nutrition, are being worked out, and it is hoped that the results may be published in more complete form within a year.

W. R. G. ATKINS.

Marine Biological Laboratory,
Plymouth, July 16.

The Phosphide Eutectic in Cast Iron.

THE accompanying photomicrograph (Fig. 1) shows the phosphide eutectic in a grey cast iron at 5000 diameters. This shows that the constituent which appears as dark markings at ×1000, and is still commonly described as iron carbide, is actually duplex, and in fact very similar to pearlite, consisting of alternate laminæ of iron carbide and iron.

FIG. 1.—Phosphide eutectic in cast iron. ×5000.

It is recognised from the research of Stead that there would be present the three constituents of the triple eutectic, namely, iron phosphide, iron carbide, and austenite, or their transition products. Thus the presence of laminated pearlite, from the transformation of austenite, is accounted for. The pearlite thus associated structurally within the phosphide masses may conceivably be richer (it probably is, but may even be poorer) in carbon content than obtains in the normal pearlite ratio, Fe_3C 21Fe. Prof. Desch,

to whom I have shown several similar photographs, confirms the foregoing explanation. The photograph was taken at 5000 diameters by means of the super-microscope. F. ROGERS.

5 Hicks Lane, Westbar, Sheffield.

"Bitumen" in Meteorites.

THE statement that is currently repeated as to the existence of bitumen in meteorites does not bear examination. It is based on a number of investigations that were made between 1834 and 1885 on the alcohol- and ether-soluble material obtained by extracting meteoric matter, but no recent work appears to have been done to throw further light on the subject. The weights of the samples examined were so small that quantitative analyses are not very convincing, but an undoubted uniformity of results can be traced.

There has been obtained a hydrocarbon (possibly containing sulphur and oxygen), melting about 114° or 120° C., accompanied by free sulphur and graphite —and this is the material, present in an extra-terrestrial body, that is quoted to-day as evidence for the inorganic origin of terrestrial petroleum.

The suggestion now made is, that the presence of the hydrocarbon is due to the action of water on carbide after the arrival of the meteorite on the earth. The evidence for this is the following :

1. Iron-nickel carbide is found in meteorites.

2. Water poured on to powdered meteorite causes the production of "an alliaceous odour."

3. Phosphide is also present.

4. The water that is usually found in meteorites is considered by authorities not to be original, but to have been taken up at some subsequent time.

5. Soluble carbon compounds have been stated to be completely removed by solvents without preliminary pulverisation of the meteorite sample; that is, they exist in cracks and pores which are just the positions into which water could percolate.

6. Solid hydrocarbons are formed by the action of water on carbides of metals of high valency. These carbides are actually present though in small quantities and not often ; these hydrocarbons are also present in small quantities and not often.

This explanation, if correct, dissipates the present contradictory evidence of the presence of, on one hand :

(*a*) graphite, suggesting crystallisation from an iron magma ;

(*b*) carbide and phosphide, suggesting high temperatures of formation ;

(*c*) an outer skin, indicating the attainment of a high temperature on reaching the earth's atmosphere ; and, on the other hand,

(*d*) of a hydrocarbon of low melting point, absolutely precluding the possibility of a high temperature after its formation. PERCY EDWIN SPIELMANN.

The Athenæum,
Pall Mall, S.W.1, August 6.

Comparison of Wave-lengths with a Fabry and Perot Étalon.

IN the issue of NATURE for June 28, p. 926, Prof. Robertson, discussing the "Comparison of Wave-lengths with a Fabry and Perot Étalon," points out that for determining fractional orders of interference it is sufficient to measure only the linear diameters of the interference rings. This practice has been used extensively at Mount Wilson Observatory for ten years. It was described in Mount Wilson Contributions, No. 137, *Astrophysical Journal*, 46, 138, 1917, and No. 202, *Astrophysical Journal*, 53, 42, 1921, where full details will be found. It was shown that the method offers marked advantages, such as (reduction of labour, (2) smaller probable erro (3) convenient numerical checks which diminish t chances of mistakes in computation.

It is unfortunate that, on account of the form which Prof. Robertson expresses the idea of t method, he has committed, inadvertently no doub the error of deriving six values of the fractional ord from only four observations, and in consequence he fin an incorrect result with too small a probable error.

It seems to me preferable to write the fundament equation in the form

$$\alpha = 1 - n + cd_n^2$$

where α is the fractional order, n is the number of t ring of diameter d_n, counting the innermost as t first, and c is a constant for all the rings of a giv line, depending on the integral order of interferenc the focal length of the projector, and the magnific tion in the spectrograph. It is evident that the tv unknown quantities α and c may be evaluated if least two diameters are measured, and that if diameters are measured only $q - 1$ independent valu of α may be found.

In the practical use of the method for extende investigations, the constant c is derived from combination of the measurements on many lines, a it becomes legitimate to obtain q independent valu of α from q diameters measured on a given line.

HAROLD D. BABCOCK.

Mount Wilson Observatory,
Pasadena, California,
July 23.

A Substitute for the McLeod Gauge.

THE results of our experiments do not confir Mr. Fleuss's statements (NATURE, July 5, p. 1 Even if the water vapour is always at a pressure le than its equilibrium vapour pressure at room temper ture, the McLeod gauge reads low and usually i consistently. The reason is, of course, to be fou in the absorption of water by glass. Water vapo will condense on glass when its pressure is raise even when the final pressure is no greater th 0·001 mm. ; the amount that condenses increas with the time, so that the reading of the gau depends on the rate at which the mercury is raise All this is quite familiar to those who work wi modern high vacuum apparatus ; but Mr. Fleuss statements, if unchallenged, might mislead so who are only beginning to acquire their experience.

NORMAN R. CAMPBELL.
JOHN W. RYDE.
BERNARD P. DUDDING.

Research Laboratories of the General
Electric Company, Ltd., Wembley,
July 28.

Life History of the Pearl Mussel.

DOES any one know what happens to the pea mussel (*Margaritana margaritifera*) between t glochidium falling off the trout, etc., and the big adu mussel ? No one seems to have seen young i dividuals, and the ordinary specimens which a found are never less than about 3 inches long a must be several years old. I have lately had anoth vain hunt for young ones in the Herefordshire Wy so far as it is accessible by paddling ; presumably th live somewhere in deep water, and not in the shallo where the adults are. The revival of the pearl fishi in recent years may have led some one to work o the life history : its investigation might be a gratef occupation for summer holidays. A. E. BOYCOTT.

17 Loom Lane, Radlett,
July 31.

A Hundred Years of Electrical Engineering.[1]

By Prof. G. W. O. Howe.

If any one event can be regarded as the birth of electrical engineering, it is surely the discovery by Faraday in 1821 of the principle of the electro-motor; that is, that a conductor carrying a current in a magnetic field experiences a force tending to move it. It is noteworthy that ten years elapsed before Faraday discovered, in 1831, the magneto-electric induction; that is, the principle of the dynamo. Four years later, Sturgeon added the commutator or "uniodirective discharger," as he called it, and in 1845 Cooke and Wheatstone used electromagnets, which Sturgeon had discovered in 1825, instead of permanent magnets. It was during the years 1865–1873 that the shunt and series self-excited dynamo, using a ring or drum armature and a commutator of many segments, finally evolved.

The early workers in the field do not appear to have realised the intimate connexion between the dynamo and the motor, for, although the principle was discovered by Lenz in 1838, it only appears to have become generally known about 1850 that the same machine could be used for either purpose. The principle underlying the whole modern development of electrical engineering, namely, the generation of electrical power by a dynamo, its transmission to a distant point, and its retransformation to mechanical power by an electric motor, appears to have evolved about 1873.

The development of the dynamo during the 'seventies and the simultaneous development of the incandescent lamp led to the general introduction of electric light during the 'eighties. Attempts to make incandescent electric lamps had been made so early as 1841, when de Moleyns patented one having a spiral platinum filament; and in 1847 Grove illuminated the lecture theatre of the Royal Institution with such lamps, the source of power being primary batteries; but it was not until 1878 that the commercial development of the incandescent electric lamp was begun by Edison and Swan.

One of the earliest complete house-lighting installations was put in by Kelvin in 1881. A Clerk gas-engine was used to drive a Siemens dynamo, a battery of Faure cells was fitted up, and every gas-light in his house and laboratory at Glasgow University was replaced by 16 candle-power Swan lamps for 85 volts. He had to design his own switches and fuses, etc., for such things were almost unknown.

For about twenty years the carbon-filament lamp held the field without a rival for interior illumination, and, although attempts were made to improve its efficiency by coating the filament with silicon, the plain carbon filament only gave way finally to the metal-filament lamp. One of the most interesting developments in the history of electric lighting was the Nernst lamp, which was introduced in 1897; the filament consisted of a mixture of zirconia and yttria, and not only had to be heated before it became conducting but also had to be connected in series with a ballast resistance in order that it might burn stably. The way in which these difficulties were surmounted and the lamp, complete with heater, ballast resistance, and automatic cut-out, put on the market in a compact form occupying little more space than the carbon-filament lamp was, in my opinion, a triumph of applied science and industrial research. The efficiency was about double that of the carbon lamp. About this time, however, a return was made to the long-neglected metal filament. The osmium lamp invented by Welsbach in 1898 was put on the market in 1902, to be followed two years later by the tantalum and tungsten lamps. The latter was greatly improved by the discovery in 1909 of the method of producing ductile tungsten and by the subsequent development of gas-filled lamps in which the filament can be run without undue volatilisation at such a temperature that the consumption is reduced in the larger sizes to 0·6 watt per mean spherical candle-power. This improvement of eight times as compared with the efficiency of the carbon-filament lamp has led to the gradual replacement of the arc lamp even for outdoor illumination. The arc lamp was introduced at about the same time as the carbon-filament lamp, the Avenue de l'Opéra having been lit with Jablochkoff candles in 1878. The open arc was developed during the 'eighties; the enclosed arc, giving long burning hours and thus reducing the cost of recarboning, was introduced in 1893, and the flame arc in 1899. During the first few years of this century the flame arc was brought to a high stage of development and the consumption brought down to about 0·25 watt per candle-power, but the necessity of frequent cleaning to prevent the reduction of efficiency by dirt, and the labour of recarboning, have led to its abandonment in favour of the less efficient filament lamp.

Before leaving the subject of electric lighting I would point out that it is remarkable that the first great application of electric power should have been for the production of electric light, since it is probably the least efficient of all its applications. The overall efficiency of a small power station supplying a lighting load and having therefore a very poor load factor would not be greater than about 6 per cent. from coal to switchboard, the steam-engine being, of course, the principal offender. Of the total power supplied to and radiated from a carbon-filament lamp not more than about 2 per cent. was radiated as light, so that the overall efficiency from coal to light was 2 per cent. of 6 per cent., which means that of every ton of coal burned at the power station with the object of producing light all but about 3 lb. was lost as heat at various stages of the transformation. Even now, with up-to-date steam plant and gas-filled lamps, the overall efficiency from coal to light is not equivalent to more than 40 to 60 lb. of coal out of each ton. The electrical engineer may derive a little comfort from the knowledge that the purely electrical links are the most efficient in the chain.

Whilst on the subject of efficiency I might point out that the difference between the prices at which coal and electrical energy can be purchased by the ordinary citizen corresponds to the losses incurred in the power station; that is to say that the cost of the generation and distribution of the electrical energy is covered by

[1] From the presidential address to Section G (Engineering) of the British Association, Toronto, August 7.

the better terms on which the power station can obtain fuel. In Glasgow the writer pays 5*l.* per ton for anthracite to burn in a slow-combustion stove; taking the calorific value of anthracite at 9000 kilowatt-hours per ton, which is equivalent to 14,000 British thermal units per lb., this works out at 7½ kilowatt-hours for a penny. For electrical energy for heating and cooking purposes the writer pays a penny per kilowatt-hour. This ratio of 1 to 7½ will correspond fairly closely to the overall efficiency of the power station. In view of the high efficiency and convenience of slow-combustion stoves, it is evident that electric heating cannot be expected to compete with them for continuous operation; for intermittent heating the question is very different.

Returning from this digression to the development of the direct-current dynamo, it may be noted that the drum armature now almost exclusively employed was invented in 1872 by von Hefner Alteneck, and gradually displaced the ring armature of Pacinotti and Gramme. Although Pacinotti's original ring armature was slotted, smooth armatures were preferred for many years, until the mechanical superiority of the slotted armature caused the disappearance of the smooth core with its wooden driving pegs which were employed to transmit the turning moment from the conductors to the core. The commutator and brushes were a great source of trouble, but by the gradual elimination of unsuitable material and by better design and methods of manufacture the commutator has been made a most trustworthy piece of apparatus. The difficulties of commutation, and especially the need of continual adjustment of the brush position, were largely overcome by the invention of the carbon brush by Prof. George Forbes in 1885. It should be pointed out that the commutating poles, which have come into use so much in recent years, were originally suggested in 1884, and are therefore older than the carbon brush.

The realisation of the idea of supplying electric current from a power station for lighting houses in the neighbourhood owed much to the energy and business ability of Mr. Edison. He exhibited his first "Jumbo" steam-driven dynamo in 1881, and installed two sets at Holborn Viaduct in the following year to supply current to neighbouring premises. The output of these sets was about 90 kilowatts at 110 volts, which was so much larger than anything previously constructed that the name "Jumbo" was applied to these sets. About 1890 the multipolar type began to replace the bipolar type for the larger sizes. The size of the single units employed in power stations gradually increased with the increasing demand, and by 1895, dynamos of 1500 kilowatts had been installed.

Ferranti was apparently the first to suggest that the power station should be outside the city, at a point convenient for fuel and water supply, and that the power should be transmitted into the city by high-voltage alternating currents. In 1890 he built the Deptford Station for the London Electric Supply Company, and installed 1000-kilowatt 10,000-volt alternators. This was the pioneer high-voltage underground cable transmission, and much was learnt concerning the peculiarities of alternating currents when transmitted over cables of considerable capacity. The following year, 1891, saw the first long-distance transmission by means of overhead conductors in connexion with the electrical exhibition at Frankfort-on-Main three-phase power was transmitted, at 8500 volts, from a water-power station at Lauffen to Frankfort, a distance of 110 miles.

This development of the use of high-voltage alternating currents followed the development of the transformer. Gaulard and Gibbs patented a system of distribution involving transformers in 1882, and although their patent was upset in 1888 on the ground of its impracticability, the present method of using transformers for the distribution of electrical power was introduced in 1885, and shown at the Inventions Exhibition in London in that year. Although from 1890 onwards there has been a steady increase in the size of alternators and transformers and in the voltage employed for long-distance transmission, the last few years have seen a really amazing increase in the size of the units employed. In 1913 the largest 2-pole turbo-alternators had an output of 3000 revs. per minute of about 7500 kilowatts; such machines are now made up to 30,000 kilowatts, and 4-pole alternators are running at 1500 revolutions per minute, with an output of 60,000 kilowatts. This increase in size and in peripheral speed has been made possible by improvements, both in the material and in the design. With a bursting speed 25 per cent. above the running speed the peripheral speed can now be raised to 150 metres per second. Improved methods of cooling and a better understanding of the various causes of loss in the armature have enabled the materials to be used at higher current and flux densities.

This great increase in the size of units is not confined to the steam turbo-generator, as can be seen from the water-turbine sets recently added to the Niagara installation. Whereas the original Niagara turbines were of about 5000 horse-power, the new ones have an output of 70,000 horse-power at the low speed of 107 revolutions per minute.

The importance of cheap electric power has led to this great increase in the size of the units in the generating stations. Any slight difference of efficiency between a 10,000-kw. and a 60,000-kw. alternator is of little importance, and would certainly not counterbalance the decreased factor of safety due to concentrating the whole power supply in three or four large units, instead of distributing it between a dozen or more units. The reason for the adoption of the smaller number of large units lies almost entirely in the decreased capital cost per kilowatt of plant. In my opinion, however, there are many cases in which too much consideration has been given to this factor, and too little to the importance of a guaranteed continuity of supply.

Until recently, the only means of producing a large amount of high-voltage D.C. power was by connecting a large number of carefully insulated dynamos in series as in the well-known Thury system of power transmission. Within the last two or three years another method has been developed, viz., the so-called transverter, which consists of an arrangement of transformers and a system of rotating brushes, whereby a three-phase A.C. supply is converted into an almost steady continuous current. The first apparatus of this type to be exhibited is installed at the British Empire Exhibition at Wembley, and is designed to deliver

ontinuous current at 100,000 volts. It can also be sed for the reverse process. It would thus enable a hree-phase generating station and a three-phase sub-tation to be connected by a direct-current transmission ine, thus avoiding not only the maximum voltage of ·4 times the effective voltage, which was one of Lord Kelvin's objections to the A.C. system, but also all rouble due to the capacity and inductance of the line.

Electric traction represents one of the most important ranches of electrical engineering. It shares with the etrol motor the distinction of having absolutely re-olutionised the methods of transport within a single eneration. In its origins it is nearly a century old, or attempts were made in the 'thirties to apply araday's newly discovered principle to the propulsion f vehicles, but, with very primitive motors and primary atteries, these attempts were doomed to failure. The levelopment of the dynamo and motor in the 'seventies pened the way to further experiments, and at the Berlin Exhibition in 1879 a line one-third of a mile ng was shown in operation, a locomotive drawing hree cars. The first regular line was opened to traffic ear Berlin in 1881; it worked at 100 volts and the urrent was collected from an insulated rail. Toronto vas the scene of one of the earliest experiments in America; C. J. van Depoele, after some experiments t Chicago in 1882 and 1883, ran an electric locomotive n 1884 between the street-car system and the Exhibi-ion in Toronto.

The difficulties were enormous. The carbon brush vas not invented until 1885, and commutation in a eversible motor with copper brushes caused great rouble; armature construction and winding was in ts infancy; the suspension of the motor and the nethod of gearing it to the car axles were problems vhich were solved only after much experience. Rapid progress was made after about 1887, and the closing ears of the century saw an enormous development, he elimination of horse tram-cars throughout the world and the electrification of a number of city and suburban railways.

Of the various systems of collecting the current, only two have survived for street-cars, namely, the usual over-head wire and the exceptional underground conduit; in the case of railways there is no necessity for a conduit, and the conductor rail is carried on insulators above the ground-level.

Although 500-volt D.C. supply has been standardised for street tramways, the relative merits of D.C. and A.C. for electric railways has been a burning topic for more than twenty years, and is now perhaps more burning than ever. It is somewhat akin to the battle of the gauges in the early days of steam railways, for it involves in many cases the problem of through-running, if not now, in the not very distant future. Although the three-phase system was successfully installed in Northern Italy, it has grave disadvantages, and the battle now is confined between direct current at an increased voltage of, say, 1500 to 2000 volts, and single-phase alternating current. In the latter case there is, moreover, a further question as to the best frequency to adopt, this being usually either 25 or $16\frac{2}{3}$. The development of the A.C. commutator motor to the stage where it was applicable to traction took place during the first few years of this century, and, although in itself it is inferior to the D.C. motor, it introduces so many simplifications and economies in the transmission of the power from the generating station to the train that experts are very divided as to the relative merits of the two systems for main-line electrification.

I can only refer briefly to the applications of electrical power to chemical and metallurgical processes. Some of these are purely electro-chemical, others are purely thermal, while in many processes the electric current performs the double function of melting and electrolysing. The possibility of electroplating was discovered so early as 1805, but the commercial application of electro-chemistry on a large scale was impossible before the development of the dynamo. Within the last thirty years the provision of an abundant supply of electrical power has led to the creation of enormous electro-chemical industries; I need only instance the production of aluminium, carborundum, and calcium carbide. These industries have usually been established near a hydro-electric plant and provide a load of very high load-factor.

I turn now to what may be called both the earliest and the latest application of electricity; that is, its use for transmitting intelligence. One of the greatest factors in the development of our modern life has undoubtedly been the network of wires and cables which has spread over the whole earth, making possible an almost instantaneous transmission of intelligence and interchange of opinions. In the early days of electrical science the discovery of a new property of electricity was followed by attempts to utilise it for this purpose. So early as 1746 there are records of the use of frictional electricity for the purpose, and distances up to four miles were tried. In 1774 Lesage of Geneva proposed 26 wires in earthenware pipes with pairs of pith-balls at the end of each wire, which flew apart when the conductor of a frictional machine was brought near the other end of the wire. A current of electricity was unknown until Galvani's discovery in 1789, and Volta's pile was first constructed in 1792. Carlisle in 1800 found that water was decomposed by passing the current from a Volta pile through it, and this was the basis of the telegraph proposed by Sömmering in 1809, in which 26 wires ended in 26 metallic points arranged in a row along the bottom of a kind of aquarium. By means of a lettered keyboard at the sending end the current could be applied to any wire, and a stream of bubbles caused to rise from the appropriate point, each point being duly labelled with its appropriate letter. The magnetic effect of the electric current was discovered in 1819, and immediately replaced the previous methods in efforts to develop an electric telegraph; except for the attempts to make a high-speed chemical telegraph, all subsequent telegraph systems have employed the magnetic effect of the current. A great many of the fundamental inventions of telegraphy were made in the 'thirties; the list includes the needle instrument of Cooke and Wheatstone, the sounder of Henry, the dot-and-dash inker of Morse, and the use of the earth as a return by Steinheil. Although the needle instrument is now obsolete, the sounder and Morse inker are still commonly employed. Many have been the devices for increasing the amount of traffic which can be worked over a single line, either by the simultaneous use of the line by a number of

operators, as in the quadruplex and multiplex systems, or by punching the messages on paper tapes, which can then be fed into an automatic transmitter working at a speed ten to twenty times that attainable by a manual operator. In the most up-to-date systems the perforation of the tape is done by the operators working an ordinary typewriter keyboard, and the received message is printed in ordinary type, a single wire carrying eight messages simultaneously, four in either direction, at a speed of 40 words per minute.

The need for telegraphic communication between countries separated by water was so much the greater because of the slowness of other means of communication, but the difficulties in laying and maintaining 2000 miles of insulated wire on the bottom of the sea must have appeared almost insuperable to the early workers; fortunately, however, there were men who had the necessary vision and courage. The flimsiness of the early cables suggests that the pioneers underestimated the magnitude of the problem which faced them, which was perhaps fortunate. A cable was laid between Dover and Calais in 1850; it lived only a single day, but it was replaced in the following year by a successful cable.

The first cable was laid across the Atlantic in 1858, and, although in the light of our present knowledge we know that it could not have had a very long life, its failure after a few weeks of preliminary communication was primarily due to misuse owing to the ignorance of those in charge. Although much costly experience had been gained in the laying of cables in various parts of the world since this first attempt to span the Atlantic, the success of the second Atlantic cable in 1866 was largely due to the scientific ability of Kelvin and to his untiring application to the project at every stage of the manufacture and laying of the cable.

Turning to another branch of electrical communication, it is no exaggeration to say that modern business life has been revolutionised by the telephone, which will shortly celebrate its jubilee, for it was in 1876 that Graham Bell invented the magnetic telephone receiver, although others, notably Reis, had been working at the problem since 1861. Bell showed his telephone in operation at the Philadelphia Centennial Exhibition in 1876, and Kelvin, who was one of the judges, brought one back with him and demonstrated it to Section A of the British Association, at its meeting in Glasgow in the autumn of 1876.

A successful telephone system requires much more than efficient transmitters and receivers, and the great development which has taken place has been largely a matter of improvement in the design of the many elements that go to make up a telephone exchange. The modern manual central-battery exchange, in which one has only to lift his receiver to call the operator and be connected in a few seconds to any one of 10,000 other subscribers, is a marvel of ingenuity and construction. But this is now gradually being replaced by the greater marvel of the automatic system, in which the operator is eliminated and the subscriber automatically makes his own connexion to the desired subscriber. Attention should be directed to two outstanding inventions in the actual transmission of telephony over long distances, namely, loading and repeaters. It was Oliver Heaviside who in 1885 proposed to improve the range by increasing the inductance of the line. Although this revolutionary suggestion fell on deaf ears for fifteen years, it ultimately proved to be one of the great inventions of telephony; it is of special importance in underground and submarine telephone cables, the electrostatic capacity of which otherwise seriously limits the range. The other outstanding novelty is the introduction of repeaters at intermediate points in long telephone lines. These repeaters are specialised types of low-frequency amplifiers; they were made commercially possible by the invention and perfection of the three-electrode thermionic valve. The attenuated speech currents arriving at the end of a section of line are amplified and thus given a new lease of life before being passed on to the new section. By using a large number of such repeating stations, telephonic communication has been established between New York and San Francisco.

Turning now to radio telegraphy and telephony, one cannot but marvel at the rapidity of its development and the inroad that it has made during the last two or three years on the domestic life of the whole civilised world. The theory of Clerk Maxwell in 1864 and the laboratory experiments of Hertz in 1888 found their first practical application in Marconi's Italian experiments in 1895 and his demonstrations in England during the following year. Much of the rapid progress was due to his perseverance, vision, and courage in perfecting apparatus for short-distance work, and simultaneously experimenting over long distances, and thus, in the year 1901, settling by actual demonstration across the Atlantic the vexed question as to whether the waves would pass around the earth over distances of several thousand kilometres or go off into space.

The accomplishment of long-distance communication bristled with difficulties, largely due to unsuspected atmospheric effects which are still little understood; but such progress has been made and is continually being made that one dare not now adopt an incredulous attitude to the wildest dreams or forecasts of what is to be accomplished by "wireless." The commonplace facts of to-day would have appeared beyond the bounds of possibility ten or twenty years ago.

By the aid of electricity the energy of the coal or of the lake or river a hundred or even two hundred miles away is transmitted noiselessly and invisibly to the city, to supply light and warmth, to cook the food, to drive the machinery, to operate the street-cars and railways. By its aid one can flash intelligence to the most distant part of the globe, hold conversations with friends hundreds or even thousands of miles away, or sit in one's home and listen to music and lectures broadcast for the entertainment or instruction of all who care to equip themselves with what may almost be regarded as a new sense. Whereas thirty years ago a ship at sea was completely isolated from the life and thought of the world, it is now in continuous communication with the land and with every other ship within a wide range. In no branch of electrical engineering, however, is there any suggestion of having reached finality; on the contrary, rapid development is taking place in every direction, and we can look forward with confidence to an ever-increasing application of electricity to the utilisation and distribution of the natural sources of energy for the benefit of mankind.

The Frequency of Birds over the High Atlantic Ocean.

By P. JESPERSEN, Copenhagen.

THE Danish Commission for the Study of the Sea has, during the years 1913 and 1920–1922, under the direction of Dr. Johs. Schmidt, made a series of marine-biological investigations in the northern part of the Atlantic Ocean and in West Indian waters. The following four expeditions have been carried out: in 1913 with the schooner *Margrethe*, in 1920 and 1921 with the motor-schooner *Dana*, and in 1921–1922 with the research steamer *Dana*. So far as circumstances permitted, ornithological observations were also made on these expeditions, and it is on the diary of these observations, in combination with notes made on various voyages to the United States of America and to the West Indies, that the present account is based. In this I shall endeavour to give, on general lines, an idea of the frequency of birds over the various parts of the Atlantic.

In what follows I deal only with observations made on the ocean, and as such I consider those made at places where the distance from land was at least 50 miles. We have in all, observations on the high seas on 462 days, covering an area from the Faroes (about 62° N. lat.) to about 5° N. lat. In the area between 10° and 50° N. lat. the observations cover the whole breadth of the Atlantic from the coasts of Europe and Africa right across to the coast of America, whereas north of 50° N. lat. observations were available only for the eastern part of the Atlantic. Of the total number of days of observation the greater part, namely 254 days (about 55 per cent.), were spent in the area between 20° and 40° N. lat. and 40°-70° W. long., thus chiefly in the Sargasso Sea. Observations were made at all times of the year, the majority (about 62 per cent.), however, having been made in the six summer months, and there are few observations for the winter months north of 40° N. lat.

It is well known that the frequency of birds differs greatly in the various parts of the Atlantic. In general, it may be said that the frequency decreases greatly with the distance from land, but there are also other circumstances which may have an influence in this respect.

In order to be able to form an opinion as to how far the frequency of birds varies for the different parts of the Atlantic, I have, on the basis of the daily observations mentioned, calculated the average number of birds observed *per diem* in the various areas. Of course these figures can by no means claim to be in any way accurate, in particular for areas where the number of birds is large, but they appear to be sufficient for giving an idea whether the frequency of birds is great or small in the various parts of the Atlantic. On the accompanying chart (Fig. 1) the average number of birds observed *per diem* within an area of 10 degrees longitude and 10 degrees latitude has been given. The figures in parenthesis give the number of days on which observations were made within the respective areas. As mentioned above, only observations have been included which were made on the high sea (at a distance from land of at least 50 miles), and only such birds have been considered which may be assumed as generally living over the high sea. Characteristic coast birds and all inland birds have been excluded from these calculations.

I have employed the following method in making my calculations: so far as possible, the number of all birds seen in the course of a day was noted down. In areas where birds appear in large flocks, the number could, of course, only be estimated, and the figures given for such areas, therefore, make no claim to great accuracy. I have in such instances placed a > before the number. When an average number is given for a certain area as, say, >13, this signifies that the average number of birds observed *per diem* within the respective area should be taken as, at the least, 13 birds. In many instances the actual number will probably be considerably higher. Birds which had followed the ship steadily for the whole day were counted once only, and the maximum number of birds seen together at one time during the day is, in such cases, given as the number of birds observed that day. Of course, there is always the possibility that the same individual bird is counted several times a day, and I have tried to avoid this so far as possible, but, particularly where individual birds of the same species are concerned, there will always remain the possibility of a repeated observation of one and the same individual. When a bird has been observed several times a day about the ship, I have considered it to be the same if at least six hours had not elapsed between the individual observations. Naturally fractions have resulted in these calculations, but all such fractions have been neglected. The average figure may therefore be understood thus: the number 1 means that the average

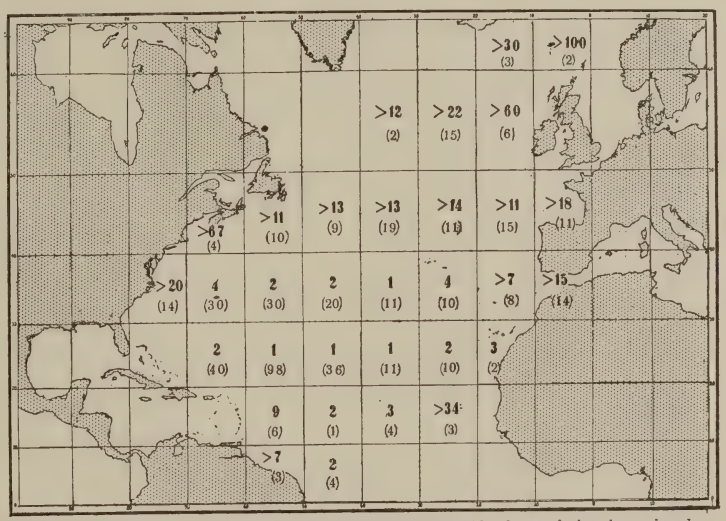

FIG. 1.—Average number of birds observed in 10° areas. The figures in brackets give the number of days on which observations were made in each area.

number of birds seen lies between 1 and 2, the number 2 that the average number lies between 2 and 3, and so on.

It is thus clearly seen in the accompanying chart that the frequency of birds is relatively larger the shorter the distance from land. Let us first consider the frequency of birds north of 40° N. lat. Here we have the largest number in the neighbourhood of the Faroes and to the west of Ireland. In the Bay of Biscay the frequency of birds is, however, considerably lower. The birds predominating in quantity here were fulmars, shearwaters, skuas, and kittiwakes.

Along the coast of America we have a high average figure south of Nova Scotia (>67). This is, in particular, caused by the large number of Wilson's petrels (*Oceanites oceanicus* Kuhl) which appears in the Gulf Stream area during the summer.

It will be observed that the frequency of birds decreases considerably with the distance from land north of 50° N. lat., but that we have quite considerable numbers over the middle of the ocean. The same applies to the area between 40° and 50° N. lat. Across the whole breadth of the Atlantic Ocean we, everywhere, meet birds in large numbers. It appears that the average figure is nowhere less than 11 birds a day. We are here chiefly in the Gulf Stream area, and the birds predominant are shearwaters, kittiwakes, skuas, and petrels.

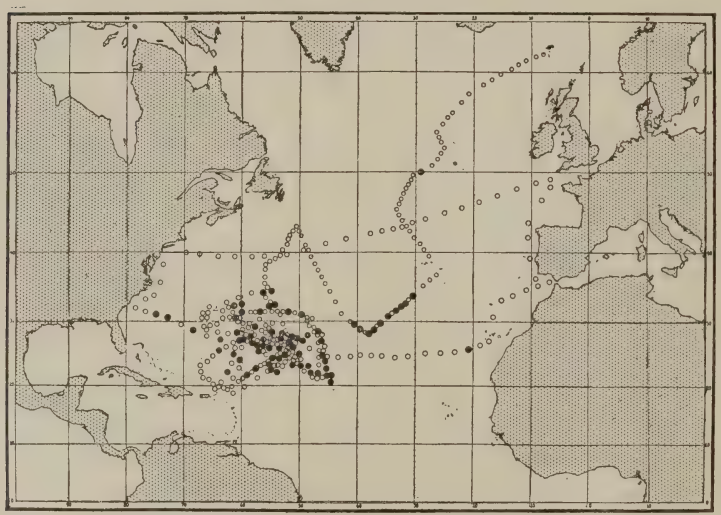

FIG. 2.—Routes of the *Margrethe*, 1913, and the *Dana*, 1920 and 1921. Black dots indicate positions in which no birds were observed during the day.

South of 40° N. lat. we notice that the frequency of birds decreases greatly. We have, particularly, ample data on bird life between 20° and 40° N. lat., and it will be seen that the number of birds is particularly small within those parts of the northern Atlantic which is generally termed the Sargasso Sea. Regarding the area between 30° and 70° W. long., it will be observed that, with the exception of the Bermuda area, the number of birds, on the average, does not exceed 1-2 *per diem*. The most characteristic bird for the Sargasso Sea is the tropic-bird (*Phaëthon americanus* Grant), but besides this bird we also observed in smaller numbers various petrels, shearwaters, and kittiwakes.

Between 30° and 40° N. lat. we have, however, a high frequency along the east coast of the United States and about Madeira, and in the Bay of Cadiz. Between 20° and 30° N. lat. the average numbers are particularly low across the whole ocean. South of 20° N. lat. we find a surprisingly high average figure about the Cape Verde Islands, owing to the sooty-tern (*Sterna fuscata* L.) appearing in flocks. The number of days on which observations were made here is, however, so small that no particular importance can be given to the individual figures.

The great difference between the number of birds on the high sea north and south of 40° N. lat. is thus striking. For still further illustrating this difference we shall, in what follows, consider another circumstance. During the various voyages it happened repeatedly that, on some days, not a single bird was seen from the ship, and it is of interest to have a look at the geographical position of such days of observation on which no birds whatever were seen. In the following chart (Fig. 2), showing the routes taken by the *Margrethe* in 1913 and by the *Dana* in 1920 and 1921, the days of observation are marked. The black dots indicate the positions in which no birds were seen during the day.

It thus clearly appears that almost all days of observation on which no birds were seen were south of 40° N. lat., being 1 day and 73 days respectively north and south of this latitude. The percentages are 1·3 and 28·1 respectively of all days of observation. This circumstance, furthermore, shows how small is the number of birds south of 40° N. lat. compared with the parts of the Atlantic north of this latitude.

The longest period during which the Danish expeditions did not see any bird was four days, and the longest period during which no birds were seen were all within the range of the Sargasso Sea, where the distance from land is considerable.

According to the available observations it appears that the number of birds within the range of the Gulf Stream is at least ten times as large as in the Sargasso Sea, and the question arises: what is the reason that birds are so scarce in the Sargasso Sea as compared with the area of the Gulf Stream? In large portions of the Sargasso Sea the distance from the nearest land is very great, and it is therefore possible that this fact is one of the reasons for the scarcity of birds, but this can scarcely be the real reason. In the central parts of the Atlantic, between 40° and 50° N. lat., where the distance from land is very considerable, the frequency of birds is, relatively, much larger than in any part of the Sargasso Sea.

The reason for the scarcity of birds in the Sargasso Sea is far more probably to be found in the small amount of food in this part of the ocean as compared to the Gulf Stream area. It seems reasonable to assume that the special fauna (fishes, crabs, etc.) belonging to the large quantity of drifting "Gulfweed" (Sargassum) must afford nourishment for more extensive bird life, but it is questionable whether this fauna plays any part as food for birds in the Sargasso Sea.

I have thus, in examining the contents of the stomachs of birds from the Sargasso Sea, never found the slightest trace of the characteristic fauna from the Sargassum, and it is therefore possible that it is difficult for the birds to catch the fishes and crabs hiding in these dense masses of drifting sea-weed. Examinations of the stomachs have, on the other hand, always shown that the birds, at least the majority of them, live on flying fishes and cephalopods. This shows that the birds in the Sargasso Sea do not avail themselves of the special Sargassum fauna but seek their food amongst fishes, cephalopods, etc., living free in the water.

It is therefore interesting to study the quantity of macroplankton to be found in the Sargasso Sea and the Gulf Stream respectively. In a previous paper [1] I have drawn a comparison between the quantity of macroplankton in various parts of the Atlantic, and it appears from this comparison that the quantity of macroplankton in the central parts of the Atlantic between 40° and 50° N. lat. is at least ten times as great as that in the Sargasso Sea.

The reason for the scarcity of bird life in the Sargasso Sea, as compared to that in the Gulf Stream area and, on the whole, in the northern Atlantic, may, therefore, safely be sought in the much smaller quantity of food to be found in the Sargasso Sea as compared to the parts of the Atlantic lying farther north.

[1] P. Jespersen: On the Quantity of Macroplankton in the Mediterranean and the Atlantic. Rep. on the Danish Oceanogr. Expeditions, 1908–10, vol. iii. 3. Copenhagen, 1923.

The Planet Mars.

By Dr. W. H. STEAVENSON.

THIS year's favourable opposition of Mars, which on August 22 is nearer to the earth than at any time between the eighteenth and twenty-first centuries, would seem a fitting occasion for a brief review of our present knowledge of the planet, together with an estimate of the prospects and probable direction of future research.

The object aimed at in physical observations of Mars may be considered as twofold. First, it is desired to determine, so far as available means will allow, the true appearance of the features presented to our view on the planet's surface; and, secondly, it is hoped, by careful and repeated observation of these features and the changes that occur in them, to reach some definite conclusions as to their real nature. Both of these objects have been kept in view from the earliest days of the telescope, but it is only in recent years that the second of them has begun to show reasonable prospect of fulfilment. The fact is, of course, that the one object is dependent on the other, so that the first must be attained, approximately at least, before the second can be pursued with any confidence of success. Thus it comes about that the history of Martian observation naturally divides itself into two stages, which we may term respectively that of cartography and that of interpretation. One, of course, is but a development of the other, and there is no sharp dividing line between the two.

From the earliest days of the telescope, it was recognised that the "spots on Mars" were relatively permanent features of the planet's surface, but the first attempts to construct even a rough map of them did not meet with much success. The drawings made by Sir William Herschel late in the eighteenth century are among the first on which we can recognise a number of markings that have since become familiar to us, and it was this great astronomer who, by his study of the polar caps, contributed the first piece of intelligent interpretation of Martian phenomena. But the first map of Mars, properly so called, was not produced until 1840, when Beer and Mädler gave to the world the results of their systematic work with a refractor of less than four inches aperture. This first map was followed, during the succeeding fifty years, by many others of increasing completeness and accuracy, each being in general the work of a single observer. During this period, thanks largely to the work of Schiaparelli, the areographical positions of the main features were fixed with some approach to finality, and a firm foundation was thus laid for future work. Finally, during the past thirty years or so, progress in cartography has been notably accelerated by the introduction of the co-operative system in observation, as exemplified by the work of such bodies as the British Astronomical Association. Meanwhile, as a result of these advances, we have begun to feel ourselves in a position to attack the problem of rational interpretation, based on the data so far accumulated. Much has, in fact, already been accomplished in this direction, and it is satisfactory to find that the theories are beginning to stand the crucial test of prediction.

To summarise all that is so far known with certainty is not altogether easy, for many of the results of observation, doubtless in most cases quite trustworthy, still lack that general confirmation which would justify us in accepting them with complete confidence. However, the following would probably be accepted on all hands as a fair statement of the present condition of definite knowledge concerning Mars.

(1) The fact of the general permanence of the larger dark markings has been established, and their positions and outlines have been determined with considerable accuracy. In other words, we are in a position to construct a very recognisable map of the planet, as regards its main features.

(2) As a result of the above, it has been possible to ascertain the inclination of the planet's axis within a few minutes of arc, and to determine the rotation period within less than a tenth of a second of time.

(3) The size and rate of diminution of the polar caps has been shown to bear a definite relation to (*a*) the progress of the Martian seasons, (*b*) the distance of the planet from the sun, and (*c*) the extent of solar radiation as indicated by the sun-spot cycle. There is now general agreement that the caps must represent frozen water, the alternative of carbon dioxide, suggested some years ago, being for many reasons untenable.

(4) The large dark markings, while in general permanent in position and outline, are known to

undergo changes in intensity, both general and local. Some of these changes of intensity are clearly seasonal and regular, while for others no definite period can yet be assigned. They are probably of a secular or irregular nature. Some typical examples are shown in Figs. 2-4. Changes of colour, of seasonal origin, undoubtedly occur, but the regularity of these has not been satisfactorily demonstrated, and all the markings do not appear to share the same changes.

(5) Both dark and light regions of the planet are subject to temporary obscuration by patches of (*a*) white and (*b*) yellow material. The former, which occur most frequently near limb or terminator, have been variously ascribed to cloud, fog, snowfalls, or hoar-frost; the latter to cloud, dust-storms, or blown sand. We are, however, not yet justified in definitely attributing a particular obscuration to any one of these causes, though probably all are in operation at some time or other.

(6) Apart from the larger markings, the existence has been established of an intricate system of finer details, the exact form of which is still uncertain, though there is not the least doubt as to its objectivity.

(7) Finally, satisfactory photographic confirmation has been secured of practically all the above results.

Further elaboration here of all the sections of this summary is not necessary, but special reference should

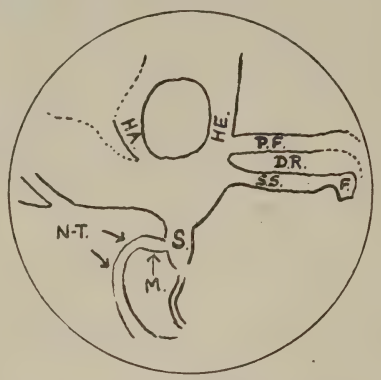

FIG. 1.—Key to Figs. 2-4.

HA.=Mare Hadriacum. S.S.=Sinus Sabæus.
HE.=Hellespontus. S.=Syrtis Major.
P.F.=Pandoræ Fretum. M.=Lacus Moeris.
D.R.=Deucalionis Regio. N-T.=Nepenthes-Thoth.
F.=Sinus Furcosus.

best qualified to judge. In the case of objects whi lie so near the limits of visibility, factors of a climati instrumental, and personal nature are bound to ent very largely into the matter, and there is consequent room for much difference of opinion. The "canals having been seen and drawn as fine lines by experienc observers using apertures of 36 and 40 inches und good climatic conditions, t failure to see them with somewhat smaller aperture in less favourable position does n carry an overwhelming amount weight; and in any event suc evidence is purely negative. O the other hand, it does not see that the linear character of t markings in question has yet bee completely demonstrated. N doubt the decision must ult mately come from the large ape tures, but it is an unfortunate fa that the ideal combination of large and perfect instrument, first-rate climate, and a thoroughl efficient and trustworthy observe who is also a finished draft man and entirely free from th bias of preconceived ideas, has never yet been attaine The evidence of photography cannot be regarded a conclusive in either direction, though it has at leas proved the objectivity of detail that is approximatel linear. Since, however, it is impossible as yet t obtain a distinct photographic image of any feature that are beyond the visual reach of an eight-inch tel

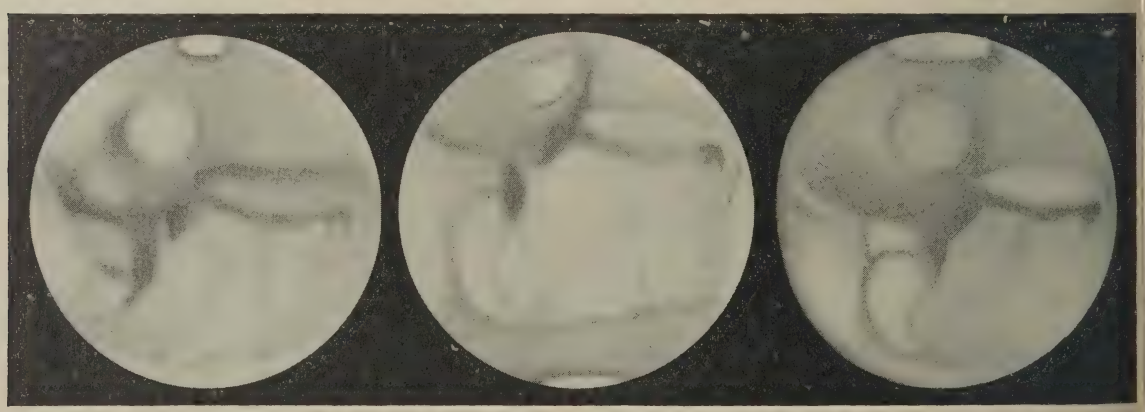

FIG. 2.—Mars. September 1909.
Note great development of Lacus Moeris, considerable breadth and intensity of Pandoræ Fretum, and darkness of M. Hadriacum as compared with Hellespontus. North end of Syrtis Major pointed.

FIG. 3.—Mars. July 1922.
Lacus Moeris only moderately developed as a mere continuation of Nepenthes-Thoth. Pandoræ Fretum narrow and faint, being far less prominent than Sinus Sabæus. Sinus Furcosus darker than the latter. Hellespontus very dark. North end of Syrtis Major blunt.

FIG. 4.—Mars. July 1924.
Lacus Moeris poorly developed. Pandoræ Fretum scarcely visible as a separate marking. Deucalionis Regio very pale as compared with area to the south of it. Hellespontus darker than M. Hadriacum. North end of Syrtis Major more pointed than in 1922.

be made to the sixth, since under this is included the so-called "canals," which have loomed so large in the more recent history of Martian observation. There seems to be a widespread impression, among those not in direct contact with the subject, that the existence of fine linear markings on Mars has been definitely and finally disproved. Actually, the question still remains entirely open in the opinion of those

scope, it follows that a really narrow line, if recorde at all, can only appear as a diffuse marking on th plate, so that we are still left in doubt as to its tru structure.

It is, perhaps, unfortunate that so much time an effort has been expended on this difficult question o the finer detail, especially with instruments that ar in any event inadequate for a final decision. Observer

apparently beginning to realise this, and more attention is now being paid, and that more profitably, to the less doubtful subject of changes in the large markings. This work is well within the compass of the instruments generally to be found in the hands of amateurs, who would do well, in the present writer's opinion, to leave the finer details to the larger apertures. In thus getting back to the partially neglected study of the more conspicuous features, we shall be correcting the mistake of attempting to run before we can walk. A good beginning has been made, but it is well to realise that it is no more than a beginning, and it will probably be many years before sufficient data have been accumulated to enable us to judge of the soundness or otherwise of current theories.

In recent years there has been much speculation as to the possible climate and temperature of Mars, and the density and composition of its atmosphere. This sort of thing is apt to blind us to the cold fact that our actual knowledge of these things, if knowledge it can be called, is still exceedingly vague, uncertain, and even contradictory. In view of this, the free and confident use of such definite terms as "cloud," "fog," "hoar-frost," and "vegetation" would seem to be somewhat premature, and liable to check progress by giving rise to a false impression of finality in our deductions. However eager we may be for a quick explanation of observed appearances, we cannot better serve the interests of research than by keeping an open mind.

Obituary.

Prof. James Seth.

In Prof. James Seth, who died of failure of the heart on July 24, at the age of sixty-four years, Edinburgh has lost one who belonged to the great race of Scottish professors. Educated at George Watson's College and the University of Edinburgh, he went through a complete course of training for the ministry at the Free Church College. Turning from his original intention to his true vocation, he studied philosophy at Leipzig, Jena, and Berlin. In 1883 he became assistant to Prof. Campbell Fraser in his own University, and two years afterwards was appointed professor of philosophy at Dalhousie College, Halifax, Nova Scotia. In 1892 he accepted a chair in Brown University, Providence, Rhode Island, and four years later the Sage professorship of moral philosophy in Cornell University. From Cornell he was recalled in 1898 to succeed Prof. Calderwood in the chair of moral philosophy in Edinburgh.

During his twenty-six years' tenure of this post, Seth made a place for himself in the life of the University and the city that would bear comparison with the most distinguished in the long line of his predecessors. Not as well known as his elder brother and colleague, Andrew Seth Pringle-Pattison, he had the same high standard of scholarship in philosophy and much of the same distinction of style in his written work. The writer of the "appreciation" in the *Scotsman* on the day after his death, remarked on "the unique partnership so fruitful in good results" between the brothers. For the rest, his methods as a teacher and the place he took in the life of the University and the city were entirely his own. Endowed with great readiness of speech and a singular power of entering into the minds of his students, he was able in spite of the size of his classes to perfect a form of catechetical instruction which was the delight of his students and made "Prof. Jim" for a quarter of a century one of the most popular teachers in Scotland.

On the other hand, related by his subject of moral (which, on his interpretation of it, meant also political) philosophy to the civic life of the community, Seth took the warmest practical interest in all advanced movements. He held that "it is for the State to emancipate from the slavery of social conditions the toiling masses of society, to endow those who are citizens only in name with a real ethical citizenship—the franchise of a complete and worthy human life," in a word, "to co-ordinate the industrial with the ethical life." It was in such a "regulative socialism" that he found the *via media* between individualistic and communistic extremes. In the same spirit he interested himself in the Settlement and kindred movements and took a leading part in the establishment of a course of study in social science with the view of linking these more closely with the University. His wide connexion with America and the Continent and his generous hospitality made the bachelor home, which he shared with his younger brother John, a rendezvous of scholars from all parts of the world as well as of his more intimate friends in Britain. It was altogether in harmony with the genius for friendship that was so marked a feature of his character that he died in the course of a round of calls upon acquaintances who were themselves in trouble. *Sic vivamus ut sic moriamur.*

Seth's chief contributions to philosophy were his book upon "Ethical Principles" (1894), now in its fifteenth edition, and the volume in the series Channels of English Literature on "English Philosophers and Schools of Philosophy" (1912). In the former of these he expounds in a masterly way and with a fine sense of the power of the English language the sober form of idealism with which, by his own teaching not less than that of Campbell Fraser, Simon Laurie, and his brother, philosophy in Edinburgh has been identified. It differs, as the student of philosophy knows, from that associated with the great sister University in the West under the influence of Edward Caird and Henry Jones, chiefly in the emphasis it lays on separate will and personality as an ultimate category and its more definite teaching on the subjects of theism and individual immortality. This is not the place for comparison and criticism, but we touch here on what is probably the main issue between Idealistic philosophers at the present time and we can ill spare the help which so open-minded and "synoptic" a thinker as Prof. Seth might have rendered in clearing it up in the greater leisure of the retirement to which he had been looking forward. We may hope that he has left behind him some record of his maturest thought upon it that may yet be published.

J. H. Muirhead.

Dr. R. H. Jude.

Much regret was felt in scientific circles at the death of Dr. R. H. Jude on June 1. Until his retirement during the War, Dr. Jude was for more than thirty years in charge of the Mathematical and Physical Department of Rutherford College, Newcastle-on-Tyne, and he played a very prominent part in the higher education particularly of young engineers on Tyneside, many of whom now occupy prominent positions in the engineering world. For several years he had been a victim of diabetes, but, in spite of ill-health and progressive deafness and blindness, he retained to the end a brave fortitude in his outlook, an active and a clear mentality, and his letters rarely lacked in that spark of dry humour so characteristic of him in earlier years.

Dr. Jude was born on December 31, 1853, at Camberwell, and after receiving his early education at King's College School, Strand, he gained a scholarship and proceeded to Christ's College, Cambridge, where he took the B.A. degree. In 1876 he was bracketed 18th Wrangler in the Mathematical Tripos, and the following year he obtained a first class, with a special mark of distinction, in the Natural Science Tripos. One year later, in 1878, he gained the degree of D.Sc. of the University of London, and for a short period after graduation he also studied at the University of Heidelberg.

During his long association with Rutherford College, Dr. Jude played a large part in the development of the scientific side of that institution. In the words of one of his former colleagues, he had "a profound and ready grasp of his subjects, and a singularly lucid power of exposition"; but above all he wielded "a quickening influence over his students, based on a lively sense of sympathy with both their difficulties and their aspirations, and he so mingled these qualities with a forestalling courtesy as to combine in a rare degree all that gives efficiency and charm to a lecturer." Whilst he took a keen and helpful interest in and had unbounded patience with his elementary students, Dr. Jude was untiring in his efforts to develop the advanced work of his department. In addition to advanced courses in mathematics, he also instituted courses in higher mathematics for engineers and a tutorial class for advanced students, held on Saturday afternoons. Those of us who were privileged to attend these classes saw him at his best, and found in him a friend to whom no labour was a trouble, so long as it might benefit his students. Not merely content with solving his students' difficulties, he often pursued their problems and derived interesting and original results, and although Dr. Jude did not publish many original papers in mathematical and physical subjects, this was undoubtedly due to the monopolisation of his time by teaching duties and problems arising from them. Nevertheless, we owe a great debt to him for his admirable treatise on physics, and for his books on elementary and advanced electricity and magnetism, all of which have been favourably reviewed in these columns. By their clearness and originality of treatment these books have done inestimable service to British students of science. Much of the apparatus described in them was of his o design.

In his youth, Dr. Jude acquired proficiency in Fren and German, and could converse freely in eith language. Moreover, in addition to Greek and Lati he made a study of Arabic. Quite late in his acti career, and in connexion with the translation of one his books into Russian, he took up the study of th language so that he might be able to look over t proofs of the translation. But perhaps the mo remarkable of his linguistic achievements took pla after his retirement. Living in Wales, and constant hearing it spoken, he obtained a considerable knowled of Welsh, in spite of failing vision, and was able converse freely with the villagers.

By his kindly, unobtrusive, and gentlemanly bearin Dr. Jude was endeared of all with whom he associate His active life was spent in the service of others. H had much to give, and gave of it unstintingly. O sympathy goes out to his widow, for whose unfailin encouragement and help he was ever grateful, especial in later years of failing sight and hearing.

Robert W. Lawson.

Prof. Albert Hesse.

The issue of the *Chemisches Zentralblatt* for May announces the death at Berlin—Wilmersdorf—of Pro Albert Hesse, who was editor of that journal from 19 until 1923. He died on May 10, after a long and painf illness, at the comparatively early age of fifty-seve The systematic co-ordination and abstracting of pu and applied chemical literature was the main achiev ment by which Dr. Hesse is known, and his great succe in this field has been and is still of great service to t chemist. The fusion of the *Chemisches Zentralbl* with the abstract journal of the *Zeitschrift für a gewandte Chemie* in 1919 was a great achievement f Dr. Hesse, and this union will help also in the solutio of the problem, yet unaccomplished, of including a abstract of the current patent chemical literature the world.

Before concentrating on editorial work Dr. Hes was an active chemist both from the academic ar industrial aspects. He was a pupil of Wallach, ar made a close study of the ethereal oils. His studies o sesquiterpene alcohols and the odoriferous constituen of flowers, including jasmin, rose, ylang, tuber, ar orange-blossom, and the synthesis of camphor we among the problems which at different times occupie his attention. He was associated for some time wit the famous firm of Heine and Co. of Leipzig, and h name occurs in many patents connected with essenti oil.

In addition to his editorial work and his contributio to patent literature, reference may be made to tw publications of a more economic character. Jointl with Prof. Grossmann he wrote a report entitle "England's Trade War and the German Chemic Industry," and in 1909 in the Wallach-festival publica tion he dealt with "The Development of the Ethere Oil Industry in the last 25 years in Germany."

J. Reilly.

Current Topics and Events.

ANYTHING that will cheapen the cost of the electrification of our railways deserves serious study at the present time. In the United States, a continually increasing number of automatic sub-stations are being employed in electric traction. It is interesting, therefore, to notice that in the extension of the London Electric Railway from Hendon to Edgware, which opened for traffic on August 18, there is a completely equipped automatic sub-station. Although there are several of these stations in Great Britain in connexion with lighting networks, this is the first to be used for traction purposes. The building has been designed for three 1200-kilowatt rotary converters with all the necessary control gear and accessories. The sub-station gets a 10,500-volt three-phase supply from the Lots Road Generating Station at Chelsea, the frequency being $33\frac{1}{3}$. It is situated at Burnt Oak, which is one mile from the Edgware terminus and four miles from the manually operated sub-station at Golder's Green. To start a rotary converter at Burnt Oak, it is only necessary to close a switch at Golder's Green, all the subsequent operations being automatic. Cooling air for the transformers is supplied by a centrifugal blower. The automatic devices protect the machines in all conditions of overload. For example, when the load is too heavy, the circuit breaker opens and a resistance is inserted in the machine circuit and the rotary is disconnected from the supply mains. After a short interval the circuit breaker closes again and connexion is re-made. If the fault has been cleared, normal operation is resumed, but if not, the same sequence of operations happens again. If this happens a fixed number of times, the breaker is automatically locked and an engineer must be sent to investigate and remove the fault.

AT the conversaziones of the Royal Societies of Western Australia and New South Wales, held on June 28 and July 2, fitting celebrations were made of the centenary of the birth of Lord Kelvin. At the former there was an extensive exhibition of Kelvin apparatus and relics, including a series of photographs and engravings of the Old College at Glasgow. Lecturettes were given illustrating various phases of Kelvin's life and work. Their titles were "Gyroscopes," "The Atlantic Cable," "The Age of the Earth," "Glacier Motion," and "Solar Heat." At Sydney, Prof. H. S. Carslaw—an old pupil of Kelvin's—gave a memorial oration. He recalled the fact that two of the most famous periods in the history of mathematics in England were the age of Newton and the years during which the school of mathematical physics arose and flourished in Cambridge. Of the great names of that period without doubt the greatest was Kelvin. He had made valuable contributions to almost every branch of mathematical physics, and was the greatest pioneer of the age of electricity. It was peculiarly fitting that Australians should commemorate Kelvin, for his work on navigation made it much safer for them to cross the 12,000 miles of ocean which separated them from the homeland. The age of steam has done much for Australia, but the age of electricity has already done more.

SCOTLAND has never yielded, nor is it likely to yield, the range of prehistoric civilisations which successively flourished in southern Britain, for the incidence of the Ice Age markedly reduced the habitable period in the northern kingdom. Yet it is possible that Scotland may furnish evidence on an important and obscure stage in the more recent history of prehistoric man, namely, on the transition from Azilian to neolithic culture. So far, the shell-mounds and kitchen middens of Oransay and elsewhere have given clues to one culture or the other, but none has shown a continuous habitation throughout the critical period. It is our belief that the places most likely to reveal such are the caves, and since these have been very imperfectly surveyed in Scotland, each new cave-excavation not only deserves commendation and encouragement, but raises hopes of outstanding discoveries. On the Mull of Kintyre, about four miles south of Campbeltown, the Kintyre Antiquarian Society has, with the assistance of Mr. L. M'L. Mann, set about excavating St. Kieran's Cave. Their findings, recorded in the *Glasgow Herald* of July 31, included an incised symbol clearly of Christian origin, flint implements, bone objects, and a human skeleton, buried in a short cist, and accompanied only by a worked flint. The skull is compared conjecturally with the famous dolichocephalic skulls of the Oban caves. The digging revealed the presence of several layers of habitation, but the details given are not sufficient to indicate the ages of the deposits, and the results of expert examination of the relics will be awaited with interest.

MR. J. H. MAIDEN, who for nearly twenty years has been government botanist of New South Wales and director of the Sydney Botanic Gardens, has recently retired under the age-limit. Born at St. John's Wood, London, in 1859, Mr. Maiden went to Sydney about forty-five years ago. Before leaving England he had studied botany under Prof. R. Bentley and Prof. D. Oliver, and shortly after settling in Sydney was employed in the Technological Museum there, becoming curator and secretary in 1882, after a year's service as acting curator. While holding these offices his botanical work was chiefly connected with economic plants, on which he contributed numerous papers to journals. In 1889 he published his well-known book: "The Useful Native Plants of Australia," and in 1890 appeared the first of the three editions of his "Wattles and Wattle-barks." During Mr. Maiden's directorship of the beautiful Botanic Gardens, Sydney, to which he was appointed in 1896, many improvements in them have been effected, and he had the satisfaction of seeing the erection of the fine new building in which are accommodated the Botanical Museum and Herbarium; this was completed in 1901. Holding important administrative and advisory posts it might be supposed that he would have had little time for authorship. Yet by his writings he has won a world-wide

reputation and a high position among the greatest botanists of his adopted country. "A Critical Revision of the Genus Eucalyptus," now in its seventh volume, is in itself a fine achievement. "The Forest Flora of New South Wales," of which seven volumes have been completed, is another. Mr. Maiden is also the author of several other independent works and of a multitude of papers in journals of societies and other publications. He has served a number of the scientific societies of Australia in various offices, and was president of the Royal Society of New South Wales in 1896–97 and again in 1911–12. Mr. Maiden became a fellow of the Linnean Society of London in 1888, and in 1915 received its Gold Medal. He was elected a fellow of the Royal Society in 1916, and in the same year was appointed to the Imperial Service Order. We look forward to the completion of his valuable Revision of the Genus Eucalyptus during the coming years.

In a circular letter dated July 10, M. Sampaio Ferraz, director of the Meteorological Service of Brazil, urges the publication of reports of abnormal weather or abnormal wind circulation in some central publication, say the *Meteorological Magazine*. The abnormal wind and excessive rain experienced in Brazil during April and May of this year are quoted as a type of the information which might be collected in this manner. M. Ferraz suggests that all information for a particular month should appear in the same number of the *Meteorological Magazine*. The scheme put forward appears to us to be highly desirable, and it is to be hoped that either the *Meteorological Magazine*, or the Royal Meteorological Society, through its Quarterly Journal, will be able to make arrangements to publish such reports as are suggested from all the meteorological services and institutes of the world, two or three months in arrear. In the past, the publication of reports of abnormal weather conditions has been left largely to the *Meteorologische Zeitschrift*, but it is highly desirable to make a more systematic collection of such data, and to make them available in an English periodical.

The August issue of the *Scientific Monthly* contains the address of Dr. Arthur D. Little to the Engineering Division of the National Research Council of the United States, under the title "Research: the Mother of Industry." After a short account of the great advances in industry during his own lifetime, he directs particular attention to the developments of the decade 1890–1900, during which Hall brought out the aluminium process, Acheson made carborundum, Willson calcium carbide, Diesel invented his engine, Cross and Bevan made artificial silk, Little himself produced cellulose acetate, Röntgen discovered the X-rays, Becquerel radioactivity, Madame Curie radium, and Marconi sent a wireless message across the Bristol Channel. On nearly every one of these discoveries an industry has been founded, and Dr. Little points out that while in the past the United States has prospered because of its cheap land and abundant raw materials, it can only maintain its position in the future by making use of every assis ance science can afford, and that industry must in i own interest support research generously.

The value of chemical evidence in archæology generally known, and there are many examples mistakes which have arisen from lack of chemic knowledge; for example, the description of early met objects from Mesopotamia as "bronze," whereas i reality they are almost pure copper. In a very bri note in the *Cairo Scientific Journal* for July, Mr. Lucas gives some further examples. The blac appearance of mummies is generally attributed to th use of bitumen, whereas it is either the result of change of the flesh itself or of resin, or gum-resi which has blackened by natural processes. N evidence has yet been found of the use of bitumen mineral pitch, although they may have been used i Ptolemaic times. Castor oil has been described a honey and as natron, alkali used in glass-making ha been described as potash though it was generally not always soda, and the presence or absence of coba as a blue colour for glass and as a pigment has bee asserted and denied without any chemical evidenc Most of the archæologists who have made really valu able progress have paid attention to the assistanc which can be given by chemistry, and in future i may be assumed that the services of the chemist wil be called in even more extensively than in the past.

In the *Empire Review* for August, the problem the mentally defective is raised again. It is a proble which is always with us, but which for that ver reason is likely to be overlooked. Discussions on th subject usually resolve themselves into heated oppos tion to all the suggested schemes for dealing with th defective, or into a fatalistic resignation to the futilit of all schemes. Miss Nelly Burdett pleads for th reanimation of public interest in the subject, whic shall lead to more earnest efforts to put these peop into such a position that they can be useful membe of their own society, since by their defect they a debarred from adapting adequately to general societ She points out the disquieting fact that with ou present system of half-hearted treatment, the rank of the mentally defective are being increased. I 1906 it was estimated that one person in every 25 was mentally defective. Now it is one in every 20 A Royal Commission appointed in 1904, after fou years' work, made recommendations which have no yet been realised. A point of considerable interes not dealt with in this article, is that emotional cor flict may mask itself in some form of mental defec and much later trouble could be spared by suitabl treatment and understanding from the beginning.

At the conference on Illuminating Engineering hel at the British Empire Exhibition on August 12, paper was read by Mr. L. Gaster summarising develop ments at the International Conference on Industria Hygiene, and the meeting of the Internationa Illumination Commission recently held in Geneva The former afforded a good opportunity of interestin experts on hygiene in illumination, and the importanc of good industrial lighting in the interests of th

alth and safety of workers was freely recognised. was suggested that the International Illumination mmission should bring before the International abour Bureau of the League of Nations problems industrial lighting, etc., with a view to their being udied by the Governments of the respective coun- ies. Industrial lighting also formed the subject of uch discussion by members of the International lumination Commission. A feature of interest is he large number of scientific and industrial bodies hich co-operate with the American Illuminating ngineering Society in the revision of their codes of chool and factory lighting. Arrangements have been ade for the National Research Council to supervise searches on the results of better lighting. These cts were mentioned to illustrate the desire for co- peration in the United States and the recognition y manufacturers and gas and electricity supply ndertakings that researches, in order to carry weight ith the public, must bear the impress of scientific nd impartial authority. After describing the methods dopted in America for promoting public appreciation f the benefits of good lighting, Mr. Gaster urged the eed for a comprehensive scheme in Great Britain, in hich all interested in illumination could join. A esolution approving the proposal of the Illuminating ngineering Society to initiate such a scheme was assed unanimously. A paper on "Illumination of lighways from the Motorists' Point of View" was ead by Mr. E. H. Fryer, and there was also an nteresting discussion on the methods of lighting dopted at the British Empire Exhibition.

A FULL report of the International Meteorological onference of Directors and of the meeting of the nternational Meteorological Committee at Utrecht, eptember 1923, an account of which appeared in NATURE of October 6, 1923, p. 523, has recently been ssued as Publication No. 112 of the Koninklijk Neder- ndsch Meteorologisch Institut. The volume consists f 191 pages. At the meeting in London, September 921, it was arranged that the next meeting should be eld at Utrecht. The president was Sir Napier Shaw, nd the assembly represented 20 countries, including, n addition to Europe, Argentine, Brazil, India, Japan, nd New Zealand. There was a very copious agenda, he rapid progress of meteorology of late years render- ng international understandings and arrangements ssential to its further advancement. Land and narine meteorology over the whole globe were con- idered as well as upper air observations, and the eneral collection and distribution of obtained results. The Appendices give a large amount of information, considered internationally, and afford much material or quiet study. The discussion includes terrestrial nagnetism and electricity of the atmosphere, solar and errestrial radiation. Special consideration is given o the exploration of the upper air, the arrangement of dates for international ascents of pilot-balloons and ballons sondes, and a time-table of issues by radio- telegraphy in connexion with weather telegraphy and weather forecasting. The subjects include marine meteorology with its important considerations of world-wide interest, réseau mondial, agricultural meteorology, the propagation of sound by means of explosions, and the study of clouds. These inter- national meetings lead to essential uniformity in methods of observation and discussion and aid much in the extension of observations for land and sea areas. For weather forecasting and for considerations of physical meteorology on land or sea as well as in the air above the surface of the globe, trustworthy and comparable data are available—the aims and objects being arranged by personal contact among those interested and responsible for the world's meteorology.

THE *Chemiker Zeitung* announces that Prof. W. J. de Haas, of Groningen, has been appointed to succeed Prof. H. Kamerlingh Onnes, of Leyden, who has resigned.

AT the annual autumn meeting of the Institute of Metals to be held in London on September 8-11, Mr. W. M. Corse, of the National Research Council, Washington, D.C., will lecture on "Recent Develop- ments in Non-Ferrous Metallurgy in the United States, with Special Reference to Nickel and Alu- minium-Bronze." Visitors' tickets for the meeting can be obtained from the Secretary of the Institute, Mr. G. Shaw Scott, 36-38 Victoria Street, Westminster.

AT the monthly General Meeting of the Zoological Society of London held on August 13 it was reported that the number of visitors to the Society's gardens during the month of July had been 266,559, showing an increase of 85,538 as compared with the corre- sponding month last year. The total number of visitors to the Gardens since January 1 had been 1,079,608, an increase of 249,239. The number of visitors to the Society's aquarium since its opening on April 4 had been 316,347.

A SURVEY of the Great Barrier Reef area has been undertaken by the Commonwealth Government of Australia, and the naval sloop *Geranium* has been detailed for the work. The vessel will have a seaplane attached for general help and work in the survey, and a preliminary flight around the coastline of Australia was recently completed with the view of deciding the kind of assistance which can best be afforded from observa- tions in the air. The commander of the *Geranium* is a member of the Barrier Reef Committee of the University of Queensland, and he will take with him two scientific investigators attached to the Committee.

A PRIZE for the physiology and pathology of alti- tude has been founded by the Alpine Sanatorium of Semmering, Austria. One thousand gold krone are offered to the author of the best work accomplished or published in the last two years, which has extended our knowledge of the action of alpine climate on man. The prize is intended in the first instance for Austrians, but foreigners can also be considered if their work has been carried out in Austria. Printed or typed papers should reach the Kanzlei of the Akademie der Wissenschaften, Wien I., Universitäts- platz 2, before December 31, 1924. Some notable English reports both from the Andes and the Himalaya deserve to be laid before the commission of judges, even if they may have to be marked not for competition.

THE communications of the Society of German Men of Science and Physicians—Gesellschaft Deutscher Naturforscher und Ärzte—are now distributed monthly with *Die Naturwissenschaften*. The *Mitteilungen* give general information about the Society. Subscriptions have been reduced to a minimum of three marks; those who can are asked to give more. The 88th meeting is to be held at Innsbruck, Austria (Sept. 21-27). The president-elect, Dr. Richard Paltauf, professor of pathology in Vienna, died on April 21. Some of the chief addresses at Innsbruck will be by Dr. Hoche on the body-mind problem, Dr. Hess on the physiology of work, Dr. Frisch on the senses and language of bees, Dr. Sommerfeld on atomic researches, Dr. Penck on the aspect of the Alps. Those intending to take part in the Innsbruck meeting should communicate with Prof. D. A. Defant, Büro der Naturforscher Versammlung, Physik. Institut, Schöpfstr. 41, Innsbruck.

THE Castner-Kellner Alkali Co., Ltd., has issued recently a number of informative pamphlets dealing with some of the chemical products which it manufactures. Among these is sodium perborate, which is used for bleaching textiles, oils, fats, waxes, and foodstuffs. In the solid state this substance is quite stable, but on solution in water it yields hydrogen peroxide, caustic soda, and borax, the last named acting as a water-softener. The formation of caustic soda might be harmful, but can be readily obviated b adding sodium phosphate or bicarbonate, or a pu mineral acid. The pamphlet entitled "Chlorine ar Chlorine Products in relation to Public Health describes the manifold applications of liquid chlorin bleaching powder, and sodium hypochlorite. Liqu chlorine is being used increasingly for sterilising po able water, and it is not generally known that a lar proportion of the London water supply is now treate with this substance in the ratio of 0·5 part of gaseo chlorine to one million of water, whereby the water improved bacteriologically about one thousand time It is well known that diseases may be contracted fro the water in public swimming-baths; 1-3 parts chloride of lime per million of water, applied ever 1-2 days, will effectually sterilise the water. Oth applications are for sterilising canal or river wat before use in condensers at power-stations, and f disinfecting streets, sewage, the farm and the kenne A third pamphlet contains, *inter alia*, directions f using bleaching powder, calcium hypochlorite an sodium hypochlorite solutions to bleach textil (other than wool), artificial silk, and paper pulp, wit or without previous scouring with alkali and a solver such as trichloroethylene. Bleaching agents co taining chlorine are now in use for bleaching an desulphurising mineral oil, and for converting u saturated hydrocarbons in such oil into saturate hydrocarbons.

Our Astronomical Column.

THE PERSEIDS OF 1924.—Mr. W. F. Denning writes: "From observations made at various stations, it appears that the shower has been less abundant than usual. On the important night of August 11, the weather was unfavourable and only enabled a few meteors to be seen through breaks in the clouds. At Ashby, Lincolnshire, Mr. King, watching occasionally a partially overcast sky between $10^h\ 29^m$ and $13^h\ 58^m$ G.M.T., saw 28 meteors, of which 19 were Perseids, from a radiant well defined at $46° + 57°$. At $13^h\ 20\frac{1}{2}^m$ a splendid Perseid several times brighter than Venus was observed shooting from $30° + 52\frac{1}{2}°$ to $26° + 50\frac{1}{2}°$. A brilliant Perseid was also seen from Warwick Road, London, S.W., and from Greenwich, S.E., on August 12 at $9^h\ 42^m$ G.M.T. It was about three times as bright as Venus and left a luminous trail for about ten seconds. The direction of the flight was from α Ursæ Majoris towards α Comæ Berenicis, so that the object was evidently a very fine Perseid. Further observations of the two large meteors referred to above would be valuable."

AN ANTI-RELATIVITY THEORY.—Articles in the July and August numbers of *Scientia* by Prof. La Rosa contain a daring suggestion as to the cause of variability in stars, including the outburst of Novæ. Few are likely to accept the author's suggestion as a *vera causa*, but the articles are worth reading as a study of the consequences that would follow from his assumptions as to the laws governing the speed of light.

Prof. La Rosa rejects not only the Einstein postulate as to the constancy of the measured speed of light, but also the previous postulate that the speed is conditioned by the medium conveying the light-waves. In fact, he reverts to the corpuscular theory, supposing that the speed of the corpuscles is the resultant between the speed of the luminous body and that of the emission of corpuscles. Taking, for example, a star moving with a speed of 60 miles per second in circular orbit the plane of which passes through the sun the difference between the speeds of emission at the tw elongations is 1/1500 of that of light, and if the tim between the elongations were (say) 2 months, and th star 250 light-years from the sun, the light emitted a the two elongations would reach us simultaneously There would thus be a rhythmic increase and diminu tion in the amount of light received during th revolution. Novæ are explained by supposing ver eccentric orbits of cometary form so arranged as t give a great concentration of light in the neighbour hood of perihelion.

PROPER MOTIONS OF THE HYADES.—Memoir No 35 of the Kapteyn Laboratory at Groningen, by th Director, Prof. van Rhijn, deals with the prope motions of the Hyades stars, based on photograph taken at Helsingfors. It contains a full discussio of the measures and reductions and a catalogue of 39 proper motions. The final mean annual prope motion of the cluster is given as 0·102″ in Positio Angle 102°. It is not difficult to separate the cluste stars from the non-cluster ones by their motion this appears clearly when the motions are plotted as series of dots the abscissæ and ordinates of whic indicate the motion in x, y respectively.

The density of non-cluster stars is found to b somewhat less than in other regions of the sam galactic latitude, and it is noted that the sam peculiarity has been found in other cluster regions We may conjecture that the cluster stars are sur rounded by dust-bearing regions, which absorb som of the light of stars in the background. The presenc of such dust round the Pleiades stars is shown b their accompanying nebulæ, the spectra of whic appear to indicate that they are dust-clouds reflectin the star light.

Research Items.

Poisons and Witchcraft in Papua.—In the August issue of *Man* the Rev. R. Lister Turner describes the methods in the use of poison in witchcraft in Papua, which exhibit a close resemblance to those practices recorded by Dr. Codrington as being followed in the island of Florida by the Melanesians. This Papuan custom, which is known by the name of "Vada," consists in stunning the victim with a club and then forcing poison plants down his throat. A magical formula is repeated over the victim and he is gradually brought back to consciousness. Later he dies. It is said that an alternative method is to place the poison in a cut in the thigh, which is healed magically so as to leave no trace of the wound. Three poisons are believed to be employed—"Matua" and "Tua," which are plants, and "Gavroa," a worm with yellow stripes; but owing to the secrecy which is essential to the success of the "Vada," it is not possible to say more than that there is a probability that poisons are used. A method in which poisons are not used has come under the notice of the authorities. In this the abdomen of the victim is pummelled with cobble stones after he has been rendered unconscious. The result in one case was death from a broken spleen.

The Inhabitants of New Caledonia and Neanderthal Man.—Prof. Fritz Sarasin has made a detailed comparative study of the osteology of the New Caledonians and Neanderthal man, of which the results are published in *L'Anthropologie*, xxxiv., Nos. 3-. He finds that in a large number of their skeletal characters the New Caledonians show a closer affinity to Neanderthal man than do Europeans; but, on the other hand, in certain features they are even more primitive than the Neanderthal group. Among these are irregularities in the region of the pterion, a more pronounced prognathism and the more simian conformation of the nasal skeleton. There are, however, a number of divergences in the two groups. The New Caledonians, for example, have a more vaulted cranium, rectangular orbits, and the radius shows little or no curvature, while all the bones of the skeleton are less robust. The general conclusion is that the New Caledonians form one of a closely-related group, including Australians, Tasmanians, and other Melaneans, which is more primitive than the fossil representatives of *homo sapiens*, Piltdown man being set aside as still indeterminate. It resembles closely the primitive ancestor of existing races, Rhodesian man possibly being the proto-Australian type, and the connecting link between the Austro-Melanesian group and a pre-Neanderthaloid ancestor.

Precursors of the Japanese Earthquake.—In two earlier papers the late Prof. Omori described semi-destructive earthquakes at Tokyo in 1921 and 1922, and, in a posthumous paper (*Seismological Notes*, No. 4, 1924) he refers to the strong earthquake of January 14, 1923. The focus lay some distance to the north of that afterwards in action on September 1, lying about 30 miles N.N.E. of Tokyo. From the duration of the preliminary tremor he assigns to the focus the unusually great depth of about 30 miles. In an appendix dealing with future earthquakes in Tokyo (written before the great earthquake) he ventures on some predictions which, unfortunately, have not been verified. "Tokyo," he says, "may be assumed to be free in future from the visitation of a violent earthquake like that of 1855, as the latter shock originated right under the city itself, and as destructive earthquakes do not repeat from one and the same origin, at least not in the course of 1000 or 1500 years," and "a great suboceanic earthquake off the coast of Izu or Awa-Kazusa peninsula . . . is not likely to occur for at least some 60 or 70 years to come." Yet it was in the latter district that the recent earthquake had its origin.

The Action of Pituitary Extracts.—In a recent paper in the *Quarterly Journal of Physiology*, L. T. Hogben and W. Schlapp (vol. xiv. p. 229) have studied the effects of pituitary extracts on vertebrates other than mammals, with the view of finding whether there is any evidence of the existence of independent components showing vascular activity in the extracts. Adrenaline produces a rise of blood pressure in all four classes of air-breathing vertebrates, but pituitary extracts in physiologically significant doses have no such effects on the blood pressure of the reptile or amphibian, there being in fact a fall of pressure in birds and reptiles, though corresponding doses of the same preparations produced pressor effects in mammals.

Insulin from the Cod-fish.—Dr. H. W. Dudley, in the current number of the *Biochemical Journal* (xviii. p. 665), shows that insulin may be obtained in large amount from the islet tissue of the cod-fish. The yield, even under unfavourable conditions, was as high as 13·12 rabbit units per gram, and probably more would have been obtained from absolutely fresh islets. It is estimated that the islet tissue of the cod contains, weight for weight, about ten times as much insulin as is present in mammalian pancreas. The material was collected from the Yorkshire shore fisheries in February and March, and placed in picric acid solution, which fixed the tissue and converted the insulin into a picrate. The insulin-containing picrate fraction was extracted with watery acetone, and the picrate converted into the hydrochloride by the method previously described by the author. The finding of such large yields of insulin in the islet tissue, which is structurally identical with the islets of Langerhans of the pancreas in mammals, furnishes us with very good proof that it is really in the islets of the pancreas that insulin is normally produced.

South American Non-marine Mollusca.—Dr. H. A. Pilsbry (Proc. Acad. Nat. Sci. Philad., vol. lxxvi.) has, under a common title, united four notes on South American non-marine Mollusca. The first deals with shells from Lake Titicaca, whence very few mollusca are known and nearly all of species confined to the lake. The varieties of *Planorbis andecolus* are specially described and figured photographically on an excellent plate. There are, further, four species of Littoridina, two being new, and a new species of Pisidium (*P. titicacensis*) which, if correctly figured, exhibits hinge characters differing from those usual to the genus. The second note, on South American genera of Ancylidæ, discusses four out of the five genera known from that continent, including a new genus, Anisancylus, founded with *Ancylus obliquus*, Brod. and Sowb., as type. Descriptions of two Brazilian Amnicolidæ, being new species of Idiopyrgus and Potamolithus, form the third note. A note on Pupillidæ collected by Dr. Baker in Curaçao and its dependencies in 1922 concludes the series. A new species and new sub-species are described. Text figures accompany all four notes.

Weather at Hongkong.—A report of the Royal Observatory, Hongkong, for the year 1923, prepared by the director, Mr. T. F. Claxton, has recently been

issued. In addition to the annual report, a Monthly Meteorological Bulletin is issued. Automatic records are obtained for most elements, and considerable care is exercised to secure the greatest accuracy. The monthly and annual values of the several elements are given in the December Bulletin, and in lesser detail in the Annual Report. The mean temperature for the year was 72°·5 F., which is 0°·6 above the normal for the past 40 years; the absolutely highest temperature was 92°·9 on August 4 (the highest on record for the 40 years is 97°); the lowest temperature was 45°·7 on January 4, whilst for the 40 years the lowest reading is 32°. Temperature was considerably above normal in March, November and December, and moderately above in April and May; in the remaining months it was nearly normal. The total rainfall for the year was 106·74 in., which is approximately 22 inches more than the normal for 40 years, the greatest fall in one day was 11·50 in. on October 31, when in a single hour the fall was 2·82 in. The maximum wind velocity for one hour was 106 miles on August 18, which is only 2 miles less than the highest on record; the maximum squall velocity on the same day was at the rate of 130 m.p.h., the highest on record. Tracks of typhoons and depressions in the Far East during the year 1923 are given, and the centre of the memorable storm of August 18 is shown to have passed over Hongkong, travelling westward from off the sea. The seismograms show that 141 earthquakes were recorded in 1923. In connexion with upper air research, 49 flights with pilot balloons were made during the year. Daily weather reports from surrounding stations are given in each Monthly Meteorological Bulletin.

A Theory of Super-Conductivity.—Herr E. Kretschmann, in the *Annalen der Physik* for June, develops a new mathematical theory of electrical conduction, and uses it to explain the phenomena near the absolute zero of temperature. He rejects the idea that the conduction electrons are moving in any kind of quantum orbit, and deals with them as a swarm, moving under the influence of an infinitely small e.m.f.; he concludes that the specific conductivity of a homogeneous isotropic metallic conductor is infinite, for a swarm with given velocity in the direction of the current, when and only when the mean retardation in this direction vanishes. This will be the case, according to the quantum theory, if none of the conduction electrons spring into the closed quantum orbits of the molecules of the substance. He supposes that near the absolute zero all the quantum orbits are occupied, so that the conduction electrons cannot spring into them. When the temperature rises above a certain critical point the exterior orbits "are broken up" by the thermal vibrations of the molecules; this apparently means that electrons in these orbits are thrown off in haphazard directions, and conduction electrons fall into the orbits after an interval, so that the average velocity of the swarm is diminished.

The Crystalline Structure of Solidified Argon.—Herr F. Simon and Fräulein C. von Simson describe, in the *Zeitschrift für Physik*, July 2, an X-ray investigation of solid argon, in which they employed the method previously used by them for hydrogen chloride. Liquid hydrogen was passed through the capillary tube of the apparatus to cool the surrounding argon to its freezing point. The lattice is cubic, face centred, with closest spherical packing; at $T=40°$ abs. $a=5{\cdot}42\pm0{\cdot}02$ Å, and the density is $1{\cdot}62\pm0{\cdot}02$. The density of the liquid at the melting point, 84° abs., has been found by Baly and Donnan to be 1·42. The atomic radius (Bragg's formula) is 1·92 Å, while the mean ionic radius of K^+ and Cl^-, which have the sa electron arrangement as argon, is 1·52 Å. It appe then that the atomic radius depends on the for acting between the atoms, and is smaller the lar the forces of attraction. The authors make use their results to study argon from the point of view the theories of Mie, Grüneisen, and Born. On approximate results can be obtained, as the data a incomplete; but it appears that the behaviour argon is different from that of the metals, in whi the exponent of the term representing attracti force at close range is $m=3$, while for argon it m be about 9.

The Intervals between the Optical Double and Triplets.—Prof. A. Landé contributes a pap to the *Zeitschrift für Physik*, June 24, in which deals with the relationship between the optic doublets and the X-ray relativity doublets. It cann be expected that the former should show the sa exactness in satisfying Sommerfeld's simple appro mate formula as that author has found in the ca of the X-ray spectra. In the latter case the process take place in the inner electronic spheres, where t conditions alter in the simplest (linear) manner wi increase of the nuclear charge, $+Ze$. The optic terms, on the other hand, depend on the motion of photo electron, which for the greater part of its pa is outside the atomic kernel; but which enters t kernel, and approaches very close to the nucleu this last part of the orbit is of the greatest importan in determining the distance between the componer of the doublet, which depends on the screening s this position. Sommerfeld found for the L double from Nb (41) to U (92), $s=3{\cdot}5$; for the optical double of elements with large atomic numbers s varies abo the number 4, for all p terms; only with the fi elements of the first period is s equal to 2. T difference between the value 4 and Sommerfel value 3·5 for the L doublets may be due to the fa that in the latter an L electron has been remove which diminishes the screening. The paper direc attention to the difficulties involved in the explan tion of the doublet distances by the relativity theor both for X-rays and for light; and also to tho involved in the alternative magnetic explanation.

Sedimentary Analysis of Photographic Emu sions.—Mr. F. F. Renwick has devised a new meth of attacking some of the problems connected wi photographic emulsions that promises to give resul of great interest (Journal of the Royal Photograph Society, August). He has constructed a water ba with regulators so that its temperature falls ve slowly but with great regularity, 0·4° C. an hou The melted emulsion is thus brought to its setti point without appreciable interference from conve tion currents. The block of emulsion obtained about 15 cm. high, and slices are cut parallel wi its base from various parts of it for examination. is found that passing from the top layer downwar the particles of silver salt increase in size, the pe centage of silver salt increases, the proportion of silv iodide to the total silver haloid increases, the turbidi decreases, and the sensitiveness increases. The sens tiveness in one case of the emulsion being 65, t layers gave as results 16 at the top increasing to 110 the bottom. By putting a clear gelatin layer und the emulsion, the larger particles fall into it and a thus more completely separated than by the oth method, or the sedimentation may be repeated c any given layer if a more complete separation wanted. Seven photomicrographs are given t demonstrate the results.

Imperial Botanical Conference.

THIS conference, the first of its kind, was held at the Imperial College of Science and Technology, South Kensington, on July 7-16, under the presidency of Sir David Prain. It was attended by a large number of overseas and home botanists, and many interesting topics were discussed.

Plant Physiology.

In the Section of Plant Physiology, Dr. F. F. Blackman organised an extremely illuminating discussion on "The Physiology of Crop Yield." In the general introduction to this discussion he indicated the five chapters of modern scientific investigation which combine to illuminate the problem of crop yield. The first dealt with the experimental study of the factors and conditions affecting growth, and was illustrated by papers from Dr. F. G. Gregory on the study of plant growth with controlled artificial light, and from Prof. V. H. Blackman on the results of electro-culture experiments. The second chapter concerned the ontogeny of the crop and duration of the development sequence. It was pointed out that crop-yield covers a wide range of special cases, the desired crop being either the whole plant, its wood, fibre, or bark, or some special morphological part, such as the petals, stamens, fruit, or seed hairs. The desired part comes at the end of a long development sequence, and, for this aspect of crop yield, detailed studies are required of the normal sequence of development of each crop plant combined with an exploration of its plasticity under natural and artificial variations of environment. Other problems arise out of the varying duration of the development sequence in the individual crop plants. These were illustrated by Mr. W. L. Balls' account of his method for analysing the development of the cotton plant by collating records of the significant stages prior to the production of cotton. The next chapter dealt with the quantitative relations between the final yield and the various "factors" which affect the development of the crop plant. Several investigators, notably Mitscherlich, have tried to formulate a general law governing the relation between the plant yield and the magnitude or intensity of all outside factors, but Mr. G. E. Briggs showed the inadequacy of such formulæ.

The fourth phase of this symposium treated of the complexity of the plant's spatial environment, namely, the soil, and was illustrated by Mr. J. J. Maskell's account of critical pot-culture work at Rothamsted. Lastly, the influence of the weather on crop yield was considered, and the great difficulty of disentangling the effects of the various components of the weather was pointed out. Dr. R. A. Fisher showed that by the methods of statistical analysis significant relations between weather factors and yield can be computed where a sufficient mass of data is available. In the general discussion which followed the presentation of the main thesis, Mr. F. L. Engledow drew a comparison between a tillering plant, such as wheat, with a non-tillering plant, such as cotton, as regards development sequence and its effect upon crop yield. Dr. H. M. Leake directed attention to the enormous influence of rainfall upon plant growth in monsoon countries, owing to the elimination of temperature as a limiting factor.

Genetics.

In the Section of Genetics, Mr. F. L. Engledow opened a noteworthy discussion on "The Economic Possibilities of Plant Breeding," Mr. W. Bateson being in the chair. Mr. Engledow confined his attention chiefly to the possibilities of hybridisation in the English wheat crop. He pointed out that the economic possibilities of breeding are measured by the prospects of producing new forms which will give better financial returns than the old. Enhanced returns may accrue from higher yield, better quality, and a number of other amenities, many of which indirectly affect yield and quality, and all influence financial return. Quality improvements, such as those exhibited by the varieties Yeoman and Yeoman II., produced by Professor Biffen, have great promise. Improvement of yield is more difficult, as the average yield of wheat per acre is already higher in England than in any other country. The best policy is to try to identify the plant characters which mainly govern yielding capacity, and then by synthetic breeding to produce optimum combinations of these characters suitable for different localities. Among "other amenities" are the qualities of disease-resistance, non-lodging, early ripening, and winter hardiness, all of which are of great importance, and the attainment of which seems reasonably possible. Dr. R. N. Salaman dealt with similar problems in potatoes, Mr. M. A. Bailey dealt with cotton, and Mr. J. M. F. Drummond with oats and turnips. In the other session devoted to genetics, Prof. J. Percival opened a discussion on "The Value of Selection Work in the Improvement of Crop Plants," to which contributions were made by Prof. R. G. Stapledon, Dr. W. L. Balls, Mr. G. O. Searle, and Mr. G. N. Sands.

Plant Pathology and Mycology.

Much attention was paid at the Conference to problems in plant pathology and mycology. Dr. A. W. Borthwick opened a discussion of much interest on the "Relation of Forest Pathology to Silviculture," in which an appeal was made for closer co-operation between the practical cultivator and the pathologist, and for the latter to confirm his laboratory investigations by further research in the forest. Mr. W. E. Hiley stressed the importance of the non-parasitic agencies which frequently cause severe mortality in seedling trees and loss of increment during later stages of growth. He urged the need of a careful study of the particular edaphic and climatic requirements of the various species used for forestry purposes, indicating that in the absence of complete suitability the trees often die or grow slowly, and are more than usually susceptible to parasitic attack. Dr. J. W. Munro and Dr. Malcolm Wilson also contributed to this discussion. Another session in this Section was devoted to a discussion on "The Relation of Plant Pathology to Genetics." This was introduced by Mr. F. T. Brooks, who summarised recent achievements in breeding disease-resistant varieties of crop plants, and pointed out the limitations of this method of disease-control. He stressed the importance of co-operative effort between plant pathologists and geneticists. Prof. Groom dealt with "Fungal Attacks on Timber," indicating the enormous losses which occur, and urging the need for more intensive research upon the problems involved. There were also interesting discussions on "Bud-rot of Palms," "Mosaic Disease of Sugar-cane," and "Brown Bast Disease of Rubber Trees."

Systematic Botany and Geology.

In the Section of Systematic Botany and Ecology, Dr. A. W. Hill opened a discussion on "The Best Means of Promoting a Complete Botanical Survey of the Empire." The present position of the Botanical Survey of the Empire was reviewed, and attention

was directed to the most pressing needs of the moment. It was pointed out that in some regions, such as India, Malaya, and South Africa, great progress had been made in the systematic study of their floras, but that in others, such as East Africa and some of the West Indian islands, little had yet been done to explore the vegetation resources. In urging that further facilities should be afforded to British botanists to go out and explore the floras of our overseas dependencies, Dr. Hill stated that at present we were indebted chiefly to foreign botanists for a knowledge of the plants of some parts of the Empire. A strong appeal was made for temporary interchanges of posts between overseas and home botanists. The value of a detailed botanical survey was emphasised, especially from the point of view of the economic resources and possibilities of the Dominions, Colonies, and Protectorates.

Another important and closely allied subject dealt with at the conference was the consideration of the best means of promoting the study of natural vegetation of the Empire in its ecological aspect. This was introduced by Mr. A. G. Tansley. It was pointed out that the modern study of vegetation regards each kind of plant covering, be it forest, scrub, or grassland, as having a natural life, economy, and history of its own. If a given type of vegetation is sufficiently well adapted to the local climate and soil, not threatened by the invasion of plants better adapted to all the conditions, and undisturbed by man, it will maintain itself indefinitely. Many kinds of vegetation are, however, mere transition phases to other types, which gradually replace the former covering by the natural invasion of individuals of different species, as, for example, when new soil, such as the alluvium of a river, blown sand, or the like, is occupied first perhaps by grasses, then by shrubs, and finally by trees. Again when forest is felled or burned, or when grassland is burned or overgrazed, new plants, often resulting in a different type of vegetation, invade and settle in the area. The original vegetation may or may not ultimately return. All these phenomena of the development of vegetation are referred to as "succession."

Such facts have, of course, long been well known to practical foresters and stock-raisers, but their systematic investigation is a modern study, vigorously pushed forward, especially in the United States, and also in some of our own colonies and Dominions, especially in New Zealand and South Africa, and to some extent in India and Burma. The results have proved most valuable as a practical guide to the treatment of the land. Overgrazing, for example, may greatly lessen or even destroy the value of a cattle range, by crippling the vegetative powers of the dominant pasture plants, and thus letting in less valuable or worthless herbs, "throwing back the succession" to an earlier stage. The range then has to be allowed time to recover by the natural succession of the grasses and other pastu plants which originally occupied it. A carefull regulated system of grazing or burning will maintai the most useful phase of the succession. The fir step towards the discovery of the most scientif and therefore the most economical and productiv treatment is the careful and thorough study, b trained investigators, of the natural compositio behaviour, and succession of the vegetation. Th has been amply proved, to mention but two example out of many, by the work of Sampson in the Unite States and of A. H. Cockayne in New Zealan The laws of behaviour of forests, on which alon can be based the most scientific treatment, are subjec to quite similar laws, and a marked feature of thi part of the Conference was the hearty support give by men with long practical experience of forestr work, such as Prof. Troup, of Oxford, who was fo many years a member of the Indian Forest Servic and by Mr. R. S. Hole, for some years botanist at th Forest Research Institute at Dehra Dun, to th proposals of the conference.

After very brief summaries of the present state o knowledge of the vegetation of the Crown Colonies an Protectorates, and of the Dominions, and a series o papers from representative men of experience o such work in different parts of the Empire, there wa a general discussion, concluding with resolution These aimed at the creation of a small central bod to superintend the preparation of a series of outlin monographs on the vegetation of the different part of the Empire. Though our knowledge is still, o course, very incomplete, it is of great importanc to collect and present what we do know in accessibl form, which will serve as a starting-point for furthe work. It is further proposed to arrange for th systematic record of future work uniform with th monographs. It is also proposed that the centra body, when formed, should at once put in hand th preparation of a pamphlet or small handbook co-operatively produced by the best availabl authorities in the Empire, dealing with the aims an best methods of field work in the study of differen kinds of vegetation, so that a practical guide may b available for new workers in this field throughout th Empire. The conference also adopted a resolutio that an adequate training for work on vegetatio should involve a practical training in systemati botany and ecology by competent teachers in th field.

At the closing session of the conference Prof. F. O Bower gave a striking address on the training o botanists, the possibility of effecting interchanges o staffs, and the need for further facilities for research which was followed by an animated discussion.

The conference terminated with a hearty vote o thanks to Sir David Prain for presiding over it labours. F. T. BROOKS.

The Maximum Recorded Temperature of the Air and its Circumstances.

IN the midst of the semi-desert plain of Jefara, between the coast of Tripolitania and the interior plateau, there exists an official Italian settlement situated about 25 miles south of Tripoli and 25 north of Gharian at some 300 feet above sea-level, known as Azizia. In 1913 Prof. Filippo Eredia, as a member of an agricultural commission, visited the locality, and wisely saw to the establishment of a meteorological station on the lines followed at many other points in the colony. He took great pains to ensure the accurate functioning of the instruments after approved methods, and has recently published the results for a period of seven, not, however, consecutive years: 1913, 1914, 1915, 1919, 1920, 1921, 1922. (Ministero delle Colonie. Sul Clima di Azizia (Tripolitania) Rome 1923.)

The mean yearly temperature for this period is 70·8° F. (21·6° C.), not an excessively high figure, but appropriate to the latitude well outside the northern tropic, the range being between 87·4° F. (30·8° C.) in July and 52·8° F. (11·6° C.) in January. Therefore, though the summer is torrid, there is a very decided cool season, slight frost being occasionally experienced with an absolute minimum for the period in question of 31·1° F. (−0·5° C.) in December. Maximum temperatures as high as 110° F. (43·3° C.), the figure

f each of the five months May to September, the a·olute maximum occurring with cloudless sky and SV. wind, on September 13, 1922, namely 136·4° F. (·0° C.), during a period of extremely high tempera- e throughout Tripolitania, even the coastal city o Tripoli recording as high as 113° F. (45·0° C.). Tis appears, and is so represented by Eredia, t be the highest authentic temperature of the air e r recorded on the globe, exceeding by 2·3° F. (3° C.) the previous "record" of 134·1° F. (56·7° C.) i Death Valley, in the south-eastern desert of Clifornia, on July 10, 1913, occurring, that is, in a s ilar, or rather higher latitude, close to the summer s stice, when the sun is nearly vertical. Records e eeding 115° F. (46° C.) are stated to be common in T politania, whilst other extremes from other regions, q oted for comparison, are 127·4 F. (53·0° C.) in the V rgla oasis of Algeria, on July 17, 1879, and 125·9 F. (·2° C.) at Jakobabad in N.W. India, on June 13, 1 97.

The remarkable circumstance connected with the A izia "record" is, we think, not so much the extra- t pical location, since it is towards the dry sub- t pical belts, where the days are longer, that the most i ense summer heats occur, but that the season of i occurrence there should have been equinoctial. Te mean temperature of the month of September for t e seven years in question is exceedingly high, s passing not only that of May, which is usual in n rthern extra-tropical latitudes, but also that of Jne, which is quite abnormal. This anomaly appears t be a local accentuation of the common Mediterranean c aracteristic of excessive summer heat lingering to a ater date than in higher latitudes, where the much g ater difference in the length of the day between s stice and equinox usually permits a rapid decline i temperature when August is over. Yet we know t t even in England there comes every few years, w h a drift northward of warm Mediterranean air, a surprising development, or resumption, of severe h t in September, with afternoon maxima at about 9 F. (32° C.), which sometimes causes the climato- l gical student to wonder how the oblique equinoctial s shine in this latitude has enough strength to raise the temperature to such levels. It should be remembered, however, that apart from the large reserve of heat stored in the air and the land- and sea-surface in autumn, and its easy transport by air currents from heated southern regions, enabling a smaller amount of solar radiation to raise the temperature to 80° or 90° F. (27° to 32° C.) than is necessary early in the summer, the very fact that the equinoctial sunshine is feebler, implying a smaller amount of surface heating, involves in turn, in conjunction with the relatively warm upper air in the autumn, a shallower vertical temperature gradient, and lessened tendency to convection, than at the high solstice. The result of this is that the heat is kept more to the surface, and that September "heat-waves," when they do occur, are liable to be scarcely less severe than those of July and August, and rather more so than those of May and June, when the fierce insolation, coupled with the yet cold upper air in early summer, favours instability with removal of the warm air from the surface and a checking of the afternoon maxima.

The circumstances attending the highest temperature which has yet been "caught" by our observing stations, may be summarised as follows: It occurred during a period of cloudless sky with light winds from the heated regions of the Sahara, in the middle of a semi-desert plain well inland from the sea, in a latitude (32½° N.) which, astronomically at least, belongs to the temperate zone, at a date (Sept. 13) only ten days on the summer side of the autumn equinox, when the sun is nearly half-way between its extreme solstitial position. The time of year is a prominent illustration of the general climatological principle that the seasonal extremes of temperature, even in continental regions, tend to lag well behind the corresponding extremes in the intensity and duration of sunlight. The latitude, too, illustrates the somewhat paradoxical principle that in general it is not the equatorial or hottest climates, that is, those with the highest mean temperatures, that furnish the occasional extremes of heat, say above 120° F. (*circ.* 50° C.), but the cooler and drier climates, near the confines of the tropics, which are intensely hot during the summer months.

L. C. W. BONACINA.

Past and Passing Peoples of Polynesia.

SOME important studies of two Polynesian peoples are published by the Bayard Dominick Expedition in the Memoirs of the Bishop Museum at Honolulu.[1] In vol. ix. Mr. H. D. Skinner gives a comprehensive account of the almost extinct Morioris of Chatham Islands. Of these only two living representatives were found in a population of foreigners, most of whom were Maoris. One other was living in New Zealand. In vol. viii. Mr. R. Linton discusses the material culture of the Marquesans, and in vol. ix. W. L. D. Sullivan their somatology. These are also a dying and diseased race and Mr. Sullivan doubts whether there is a wholly sound physical specimen save, while Mr. Linton considers that their language and portions of their culture may be preserved for several generations by their numerous half-Chinese or half-European descendants, who are more resistant to disease than the pure-blooded natives.

Mr. Linton's account of the Marquesans is restricted to their material culture, and other features having been dealt with elsewhere, only a short summary is given of social organisation and religion. But houses, canoes, stone artifacts, weapons and implements, clothing and ornament are described in detail and illustrated by forty-four full-page plates and eleven figures in the text. The few local differences in the islands are set out in a comparative table, which is repeated in greater detail to exhibit the relations of the Marquesan material culture to that of other Polynesian groups. Samoa and Tonga are found to have a closer cultural agreement than any other two localities. The Marquesas and New Zealand are almost equally close. The Society Island culture comes between the Samoan-Tongan and the Maori-Marquesan. Hawaiian culture resembles the Maori-Marquesan on the material side, but is more nearly related on the non-material side to the Society Islands and Western Polynesia.

The author gives the following hypothesis of the historic distribution of races and culture in the Pacific. The first arrivals in Central and South-east Polynesia were Negroid and Melanesian rather than Polynesian in culture. They settled in Tonga, Samoa, the Cook, Society, Austral, and Tuamotu groups. They did not reach the farther islands and came from Melanesia, probably Fiji. The next comers

[1] "The Material Culture of the Marquesas Islands." By Ralph Linton. Memoirs of the Bernice P. Bishop Museum, vol. viii. No. 5 (Bayard Dominick Expedition. Publication No. 5.) Honolulu, Hawaii, 1923.
"The Morioris of Chatham Islands." By H. D. Skinner. Memoirs of the Bernice P. Bishop Museum, vol. ix. No. 1. (Bayard Dominick Expedition. Publication No. 4.) Honolulu, Hawaii, 1923.
"Marquesan Somatology with Comparative Notes on Samoa and Tonga." By Louis R. Sullivan. Memoirs of the Bernice P. Bishop Museum, vol. ix. No. 2. (Bayard Dominick Expedition. Publication No. 6.) Honolulu, Hawaii, 1923.

were of the Caucasic race and came by way of Micronesia from Indonesia to Samoa. They produced a hybrid race and the south-east Polynesian type of culture. A fairly pure group of this Caucasic race reached the Marquesas and, mixed with the Negroids, arrived in Easter Island. Another group passed through Melanesia and modified the culture of the Eastern Melanesian Islands. The last comers were the Indonesians, who entered by way of Micronesia and thence passed to Tonga and, mixed with earlier people, to Hawaii. In Samoa they were resisted for a time by the earlier population, which in Niue survived into historic times. From Western Polynesia the Indonesians colonised New Zealand, spread over South-east Polynesia and reached the Marquesas. Later movements from the west have modified the culture and rendered it extremely complex.

In Mr. Sullivan's study of Marquesan, Samoan, and Tongan somatology, the distinctions of race are elaborated in a series of anthropometric tables based upon the examination of 84 adult men and 74 adult women of the Marquesan islands. These were compared with his similar studies of Samoans and Tongans in other papers. His estimate of the physical condition of the people has been already quoted. The measurements show the Marquesans to be "tall, with long, wide head, a high, wide face, and a high, wide nose. All of the dimensions of the head and body are large, indicating their massive size. They are on the verge of brachycephaly. But one cannot be sure that the heads are wholly undeformed."

According to Mr. Sullivan the "Polynesians" of the Marquesas, Samoa, and Tonga are a mixed people. He finds in them three racial types. In addition to the Polynesian population there is a second type resembling the Indonesian peoples of Malaysia, and a third extremely short-headed element. He has dealt mainly with the Polynesian and Indonesian types. The former are taller, with longer heads, higher faces, narrower noses, perhaps straighter hair, more beard and body hair, and lighter skin than the Indonesians. They appear thus to be the Caucasic people of Mr. Linton's hypothesis.

Mr. H. D. Skinner's monograph on the Morioris is exhaustive as regards the material culture of the people and their relation to the Maoris and other Pacific islanders. It is prefaced by an admirable summary account of the bodily and mental characteristics of the Morioris, their language, social organisation, and religion. This is derived partly from the very scattered accounts of earlier writers but has been considerably extended by Mr. Skinner's own investigations in the Chatham Islands. As in the Marquesan papers, the illustrations are an important feature. The paper before us contains thirty-six figures in the text, and thirty-five full-page plates.

With regard to the origin of the Moriori, Mr. Skinner gives a summary of their own traditions as recorded by Shand and the Maori version of Whatatoro, which was accepted as accurate by Mr. Percy Smith and Mr. Elsdon Best. The Moriori account seems to show at least two principal immigrations from unknown lands, the last of which took place, if the genealogies may be relied upon, about thirty generations ago, or about A.D. 1175. According to the Maori account they were a portion of the original inhabitants of New Zealand, called Maruiwi, who had been driven by a storm while fishing from a great land south-west of New Zealand. Mr. Skinner points out the inherent improbabilities of this story: the presence of women in a fishing party, the food required for a thousand-mile journey, and the impossibility of people in the cultural stage attributed to the Maruiwi possessing ocean-going canoes. The Maruiwi, moreover, were the physical antitheses of the Moriori. They were tall, thin, dark-skinned, with flat noses and straight hair, whilst the Moriori are short and bulky, brown-skinned, with prominent noses and hair often waved and sometimes frizzy. The Maruiwi lived wholly on forest produce, and knew nothing of fine weaving, but the Morioris had a traditional knowledge of cultivated plants, and made fine matting. Not one of the Moriori weapons described by Mr. Skinner is mentioned in the account of the Maruiwi.

Mr. Skinner's final remarks are important. The craniology of the Moriori shows close relationship with the Maori, and some social features are identical. The language is divergent, but Mr. Skinner suggests a likeness to the Kaitahu of South New Zealand. The evidence of material culture is decisively in favour of a Maori origin, though some evidence appears of a likeness with Easter Island and Melanesia in the conception of human and animal forms in art and in some hooks and adzes.

Taken as a whole these three studies considerably increase our knowledge of the Polynesians. But the conclusions have yet to be compared with the evidence of language, sociology, and religion.

SIDNEY H. RAY.

Ancient and Modern Arithmetic.

THE special object of the papers referred to below[1] appears to be to establish one main thesis, namely, that there was no such thing as arithmetic in our modern sense before the sixteenth century. To quote the author's words: "Modern arithmetic, which is a peculiarly Western invention, is yet barely 400 years old. Prior to 1500, and during some 3500 years of unbroken mathematical continuity and evolution, the science and art of calculation differed absolutely from anything in vogue with us."

The sole direct argument by which the author supports this thesis is the occurrence, in two particular treatises on arithmetic which he quotes, of a method of multiplying two digits to which he applies the general term "calculation by deficients." The anonymous English author of "An introduction for to lerne to recken with the pen, or with the counter, accordying to the trewe cast of algorism, in hole numbers or in broken, etc," written in 1546, multiplies 7 by 5, and for this purpose substitutes $(10-3)$ for 7, arriving at the result by a process which is equivalent to $7\times5=(10-3)\ 5=50-15=35$. The Frenchman Oronce Fine (not "Finé"), whose work was first published during the years 1530–32 (not 1525), uses an even more roundabout process equivalent to $7\times5=(10-3)\ (10-5)=15+(7-5)\ 10$ [or $(5-3)\ 10$] $=15+20=35$.

Now this "complementary" method of multiplication (as it has been called) is a familiar item in most histories of mathematics: there is nothing new in Prof. Brockwell's discovery. He says, indeed, that the anonymous English treatise "appears to have been entirely overlooked by all the more recent writers on the history of mathematics both in Europe and America"; but, if he had referred to David Eugene Smith's "Rara Arithmetica" (1908) he would have found (p. 244) a notice of this anonymous work and of the later edition of it published in

[1] "The Transition from Ancient to Modern Arithmetic, I. II." (reprinted from *The Teachers' Magazine*, Montreal, Dec. 1923 and April 1924); "Calculation by Deficients (a remarkable aspect of the Evolution of Arithmetic)," a paper read before the American Oriental Society, April 23, 1924; by the Rev. C. A. Brodie Brockwell.

574. He would also have found in the same "Rara Arithmetica" (p. 76) a case of "complementary" multiplication from an earlier treatise (Huswirth, 1501). But the strange thing is that our author seems to infer from these cases that before 1546 such multiplications were never done in any other way, that "none of our tables of arithmetic had been invented as recently as 1500 A.D.," that our multiplication-table had not been invented," and that, "while men could multiply, as we do, up to five times five by the fifteenth century, they could not go beyond this." There is, indeed, no trace of multiplication-tables in Egyptian records, but the Babylonians had not only multiplication-tables but also tables of divisions, of squares, of square roots and cube roots. The Greeks and Romans certainly had multiplication-tables: there is one in Nicomachus about A.D. 100) and in Boëtius (about A.D. 500), and they must have been used much earlier. There are also multiplication-tables in a treatise on abacus-reckoning by Bernelinus (about A.D. 1020), in the "Liber abaci" (1202) of Leonardo of Pisa, and in Widman's Arithmetic (1489). So much for the multiplication-table. (The fact that Pepys had such trouble in learning the multiplication-table is of course no proof that schoolboys and others had then (1662) only just begun to use it, and that it was then little more than 100 years old; other great men have been without a gift for arithmetic.)

The story of the arithmetical operations is similar. Eutocius (5th century A.D.), in his commentary on Archimedes, gives various long multiplications differing from ours only in the arithmetical notation used. Theon of Alexandria (4th century A.D.) divides 3515° 20′ 15″ by 25° 12′ 10″ and extracts the square root of 4500° in degrees and sexagesimal fractions by a procedure which, allowing for the difference of notation, is the same as ours. Long multiplications in the Treviso Arithmetic (1478) are done in a way exactly equivalent to our method, and in some cases they are written out in exactly the same form. So with long divisions, which appear, in the same form as with us, in an Italian MS. of about 1460 (see D. E. Smith, *op. cit.* p. 462), and in printed works by Calandri (1491) and Luca Paciuolo (1494). It is true that some ancient systems of numerical nomenclature expressed certain numbers on a subtractive principle: cf. the Roman *undeviginti* and *duodeviginti* for 19, 18, etc., and the numeral signs iv., cxc., etc. The Babylonians, too, used the same principle commonly, if not so systematically: *e.g.* we find 118 written as 120 *minus* 2, and 27 as 30 *minus* 3. Possibly the 'complementary' multiplication owes its origin to this feature of the Roman numeral system. But there seems to be no trace in India, Arabia, Egypt or Greece of the "complementary" method of multiplication.

Such being the facts, few, we imagine, will agree that arithmetic was dominated continuously from the earliest times to the sixteenth century by "calculation by deficients," and that our modern arithmetic was a Minerva-like offspring of that century.

Prof. Brockwell finds indirect evidence for his theory in a multitude of allusions in literature which hint at odd systems of numeration and curious processes of calculation. He draws mostly from Hebrew and Biblical sources and states a number of interesting puzzles, *e.g.* "Why from time immemorial had *aleph*, the first letter of the Hebrew and Phœnician alphabet, the index both of 1000 and of 1?" "Why, when speaking of the seven days of the first creation story, did the mediæval Hebrew exegetes describe them as seven thousand days?", and so on. These puzzles may no doubt offer a considerable field for further research into primitive arithmetic.

We may observe incidentally that our author assigns Philolaus to the 5th century A.D. (instead of B.C.), making Isidorus, Bishop of Seville (A.D. 560–636), "a little over a century later." He also speaks of Proclus, the Neo-Platonist, as "the Egyptian mathematician"!

University and Educational Intelligence.

Liverpool.—Applications are invited for the Derby chair of anatomy, the duties of which post will begin on January 1 next. The latest date for the receipt of applications by the registrar is October 1.

A demonstrator is required in the department of mathematics of the City and Guilds (Engineering) College, South Kensington. The latest date for the receipt of applications and statement of qualifications, by Assist. Prof. Klugh, at the College, is August 30.

Applications are invited for two research assistantships in the Physical Laboratory of the University of Toronto. Candidates must be university graduates with special training in physics. Applications should be sent to Prof. J. C. McLennan at the University.

Applications are invited for the professorship of surgery in the University of Otago, New Zealand. Particulars of the appointment and a form of application may be obtained upon written request to the High Commissioner for New Zealand, 415 Strand, W.C.2. The completed form must be returned by August 31.

As part of the Vacation Course for Teachers arranged by the West Riding Education Committee at Bingley, Mr. Wilfred Mark Webb, general secretary of the Selborne Society, gave a lecture and demonstration on August 12 dealing with "The Cinematograph in Education." He considered two aspects of the subject, namely, the use of moving pictures in the ordinary curriculum in connexion with the definite teaching of various subjects in which it is recognised that they may be helpful, and during out-of-school hours for broadening the pupils' outlook. He strongly emphasised the need at present of superseding the lantern slide only when it is advisable to represent movements which are going on, or can be introduced as an improvement upon the still picture, and even upon the blackboard, in the building up of drawings, diagrams, or maps, or by making models work upon the screen.

In continuation of the policy of training aircraft apprentices in the skilled trades of the Royal Air Force, two examinations for the entry in January next of more than 500 boys, between the ages of 15 and 16½ at the time of entry, will be held on October 17 and November 4 respectively. The closing date for the receipt of completed forms of application for the first examination, which is an "open" competition conducted by the Civil Service Commissioners, is August 28, and for the second "limited" competition, which is carried out by the Air Ministry in conjunction with the local education authorities, the forms of nomination must be received in the Air Ministry by October 7. For the former, forms of application can be obtained from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1. For the latter, nominations can be obtained through headmasters of schools, Advisory Committees for Juvenile Employment, the Boy Scout Association, and officers commanding Territorial Cadets.

A "FEDERALISATION" of the London Institute of Historical Research in the interests of students in all British universities has for some years past been advocated by Sir Richard Lodge, and he was able to announce at the universities' conference of May 10 that the idea had been adopted by the Council of the Institute. In America a movement of a similar character has been set on foot with the object of utilising in the future more fully than in the past the material and scholarly resources at Washington for purposes of graduate study and research by students from all parts of the United States. The attitude of the leaders of the movement is summed up in a phrase used by Prof. Leuschner of California in a paper presented last November to the Association of American Universities: "Every graduate school should extend to Washington." Prof. Leuschner went on to say that American graduate students move about more and more freely and that this development is not merely due to the advice of deans and professors but is increasingly due also to the scholarly initiative of the students themselves. He admitted that this freedom is "impeded at times by a certain *local pride or provincialism of departments* and their representatives, who fear loss of students and of prestige by carrying it to its logical conclusion." He stated, however, that it is fully recognised that few universities can undertake distinguished work in many branches. On the important question whether fellowships are allowed to operate as impediments to free migration, he went no further than to say that he hoped no fellowships are being maintained that are not primarily established for the fullest enjoyment of great opportunities in the field of scholarship and research.

THE report of the Imperial Education Conference Committee on the use of the cinematograph in education has been issued recently (H.M. Stationery Office, 1924. 1s. net). Not the least part of the value of the report lies in the extracts from memoranda submitted by inspectors and secretaries of education who have watched experiments, by headmasters who have introduced films into their schools, and by teachers who have actually used the cinematograph in teaching. The positive conclusions reached are those which are fairly obvious: namely, that the cinematograph can be of real value as an adjunct to present methods, and that it should be recognised as part of the normal equipment of educational institutions, especially for use in teaching nature study, geography, science, and industrial processes. It is noteworthy that those who have had practical teaching experience with the instrument are much more enthusiastic than are others. Though nothing is said in the report, opinion seems to be swinging round to the view that the classroom rather than the picture theatre is the place for educational work with the film. Importance is rightly attached to the fact that projectors and screens now exist quite suitable for use in a classroom, and that the technical difficulties which used to prevent their use have disappeared, though the difficulty of cost remains. The absence of suitable films is, however, referred to again and again. One hint is given, that films should not take longer than ten minutes to run through; the writers of this note would say five; but this does not carry us very far. The crux of the problem is reached when the Committee says that the films "which are procurable are unco-ordinated and do not fit in with one another or with the ordinary school syllabuses." It is the well-thought-out teaching syllabus which dominates the situation, and film producers who desire to get the patronage of, or to help, teachers must take account of it.

Early Science at the Royal Society.

August 26, 1663. It being related by Mr. Oldenburg the secretary, that he had been desired by Monsieur Ludolf, councillor of the duke of Saxe-Gotha, to procure from the society, for a domestic of that prince who was to be sent into Egypt and Ethiopia, some instructions of inquiries fit to be made in those parts; the society desired Mr. Boyle, Mr. Henshaw, and other members to draw up some queries for that purpose. [Among these was one, "Whether, tho' the plague be never so great before, yet on the first day of the river's increase, the plague not only decreaseth, but absolutely ceaseth; not one dying of it after?"]

August 27, 1662. Upon the occasion of the manuscript philosophical books, which were presented to the society for their examination, and received a good character from those members, who had read them, it was ordered, that no books presented to the censure of the society shall receive approbation from them; but only, if the society think fit to refer such books to one or more of the fellows, esteemed by them competent judges thereof, that the report made thereof to the society by such fellows, may be communicated to the authors of the books thus presented; and that it may be signed by one of the secretaries.

August 28, 1661. Dr. Clarke read a paper entituled "Observations on the humble and sensible plants in Mr. Chiffin's garden in St. James's Park, made August 9, 1661."—Mr. Boyle presented the book which he had published since the order was made, that every member, who should publish any book, should give one to the society's library.

August 29, 1662. In the afternoon of this day the president and council, with other members of the society, waited on the king, to return him the thanks of the society for the patent of their establishment. The president made a speech to his majesty [This extols the king's grace and favour, and expresses "our firm resolution to pursue sincerely and unanimously the end—the advancement of the knowledge of natural things, and all useful arts, by experiments."]

1678. His grace the Duke of Norfolk being present at this meeting, renewed the declaration of his gift to the Society of the Arundelian library; and gave his consent and direction for the removal thereof: and that they should have liberty to exchange such books thereof, as were duplicates, or which they should think not so proper for their use, for others of equal value. His grace added, that Sir William Dugdale had presented him with a catalogue of books of heraldry, as he in the name of the heralds had desired. But upon perusal of the same finding many of them to be such, as did not so properly belong to the business of heraldry, the duke was desirous, that Sir Robert Redding and Mr. Evelyn would peruse the said catalogue, and consider what were most proper for the college of heralds, and what might be more proper for the use of the Society, and to moderate and adjudge the matter between the Society and college. But it was his grace's further pleasure and desire, that in case the Society should be dissolved (which it was his desire and hope they never would be) the said library might revert to his heirs. The Society by the mouth of the president returned his grace their most humble and hearty thanks for this his truly noble present: and ordered Mr. Hooke to take care, that the determination of the matter between them and the college of heralds might be made with all convenient speed; and that thereupon the books should be forthwith removed to Gresham College.—Mr. Henshaw moved, that a fair catalogue of them might be made, to be delivered to the duke to remain in his grace's custody.

Societies and Academies.

PARIS.

Academy of Sciences, July 21.—M. Guillaume Bourdan in the chair.—A. **Lacroix**: The grained motive rocks of the archipelago of Kerguelen. Complete analyses of twelve rocks collected by M. E. Peau; including nepheline syenites, phonolite, quartziferous syenites, biotite granite, trachyte, and basalt. These rocks suggest the existence of much older volcanic formation than the lava constituting the main formation of the archipelago.—Paul **Appell**: The movement of a heterogeneous fluid mass, subjected to the mutual attraction of its particles, round the centre of gravity.—A. **Haller** and (Mme.) P. Bagnart: The preparation of the monoalkylpulegones.—Ch. **Moureu**, A. **Lepape**, and H. **Moureu**: The radioactivity of some thermal springs of Madagascar (the Antsirabe basin) and of Reunion. Determinations of the radium emanation in the gases from seventeen springs in Madagascar and eight in Reunion have been made. Minute amounts of thorium emanation were detected in one spring only.—Gabriel **Bertrand** and Hirosi **Nakamura**: The comparative physiological importance of iron and zinc. Experiments on young mice show that a deficiency of zinc in the food produces a more marked effect on growth than a deficiency of iron.—Charles **Rabut**: The rounding of dams and chimneys.—E. **Mathias**: The terminal forms of flashes of lightning.—M. de **Séguier**: The isomorphisms of certain groups.—Emile **Jouguet** and Maurice **Roy**: The paradox of d'Alembert in the case of compressible fluids.—J. **Guillaume**: Observations of the sun made at the Lyons Observatory, during the fourth quarter of 1923. Observations were made on 56 days, and the results are given in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—R. **Jarry-Desloges**: Contribution to the study of the disaggregation of the southern polar-cap of the planet Mars.—Charles **Platrier**: Contribution to the study of various physical phenomena by transformation of linear differential equations into integral equations.—L. **Dunoyer** and P. **Toulon**: A remarkable property of the positive column of the mercury arc. Action by the influence of external baths.—L. **Vegard**: The luminescence of solidified gases and their application to cosmic problems.—G. **Bruhat** and M. **Pauthenier**: The absorption of ultra-violet rays by carbon bisulphide.—J. **Errera**: The solid state looked at from the electric point of view; dispersion in the Hertzian domain.—J. **Escher-Desrivières**: Polonium carried down by silver chloride. A quantitative study of the removal of polonium from solutions by precipitation of silver chloride, the solution containing variable amounts of hydrochloric acid, sodium chloride, and potassium chloride.—J. H. **Le Bel**: Small variations in the heat dengaged by various specimens of radium bromide. A specimen of radium bromide, placed in a Dewar tube in a cellar 20 metres below ground, gave a perfectly steady temperature rise, which, however, once or twice a month, showed a slight fall. A second apparatus, placed under the same conditions, indicated the same minima at exactly the same times. The phenomenon appears to have its origin outside the radium, and it would be desirable to repeat the experiment elsewhere, preferably in America.—James F. **Brennen**: The carrying down of polonium by colloids. The colloid is precipitated by an electrolyte, and the amount of polonium in the precipitate determined. It depends on two factors; the time that the polonium has been in contact with the colloid before precipitation and the time that the precipitate has been allowed to stand before filtration. Colloidal silver or ferric hydroxide retains practically all the polonium (97 to 98 per cent.).—D. **Yovanovitch**: An apparatus for measuring the heat disengaged by radioactive bodies.—Jean **Thibaud**: The γ-rays of very great quantum and the photo-electric origin of the natural β spectrum of radium.—André **Job** and Guy **Emschwiller**: The photochemical limit and the energies of linkages.—H. **Gault** and F. A. **Hessel**: The pyrogenic dissociation of hexadecane. The apparatus used has been described in detail in an earlier communication. Analyses of the gas and liquid produced are given for seven temperatures varying between 390° C. and 815° C.—P. **Langlais** and J. **Goby**: Contribution to the study of essence of iris. In addition to the constituents already known, the presence of six saturated fatty acids has been proved, caprylic, pelargonic, capric, undecylic, lauric, and tridecylic acids.—Marcel **Delépine**: The transformations of the pinenes by acids.—Max and Michel **Polonovski**: The degradation of the hydrogenated derivatives of eserine.—**Pastureau** and H. **Bernard**: Ethyl-trimethyl glycerol.—Alphonse **Mailhe**: The decomposition of animal wax. A study of the destructive decomposition of beeswax in the presence of catalysts.—Pierre **Viennot**: The boring of Abatilles, near Arachon.—Emile **Belot**: The application of the principles of the dualist cosmogony and of isostasy to the study of various geological problems.—J. **Cabannes**: The transparency of the atmosphere.—J. **Liouville**: The corals harmful to the trawlers of Morocco.—Mlle. Y. **Ménager**: The use of sodium chloride as a standard in analyses of sea-water.—René **Souèges**: The embryogeny of the Typhaceæ. The development of the embryo in *Sparganium simplex*.—Mme. Paul **Lemoine**: The distribution of the calcareous algæ (Corallinaceæ) according to depth in the Mediterranean.—André **Mayer** and L. **Plantefol**: The water exchanges of mosses with the atmosphere.—André **Charriou**: The absorption of potash by humic acid.—F. **Heim** and R. **Audubert**: The agglutinating power and coagulating power of coagulation agents towards rubber latex.—Ladislas **Smolik**: The influence of electrolytes on the total surface of the elements of the soil.—R. **Fosse**, Ph. **Hagene**, and R. **Dubois**: The gravimetric estimation of cyanamide as xanthyl-urea.—Jules **Amar**: The preservation of living tissues. The solution proposed contains sodium phosphate, 3·0, sodium bicarbonate, 3·0, and sodium chloride, 2·0 in water 1000. Advantages are claimed for this solution over the solutions of Locke, Ringer, and Biedermann.—Auguste **Lumière** and Henri **Couturier**: The toxicity of normal sera.—L. **Mercier**: *Geomyza sabulosa*, a microdiptera with reduced wings; loss of the faculty of flight in this species as a result of the drosophilian process.—G. **Athanassopoulos**: The geographical distribution of fresh-water fishes in Greece.—Mlle. **Kostritsky**, Mme. **Toumanoff**, and S. **Metalnikow**: *Bacterium tumifaciens* in the grub of *Galleria mellonella*.—M. **Weinberg** and A. R. **Prévot**: The use of anatoxins for the preparation of antigangrene sera.— — **Paillot**: The etiology and epidemiology of *grasserie* (a disease of the silkworm).—Mme. Jean **François-Péry**: The influence of sunlight on the development of a soil protozoa, *Colpoda cucullus*.

SYDNEY.

Royal Society of New South Wales, May 7.—R. H. **Cambage**: Presidential Address, Australian resources of liquid fuels. Mr. Cambage expressed the opinion that it is imperative the most intense research should be undertaken to devise, on commercial lines, some method of treatment of coal by which a very much higher percentage of liquid fuel may be extracted or manufactured from this commodity than is obtained by present-day methods in connexion with coking, or that some other process, such as that of com-

bustion of finely divided particles, may be perfected, by which the power may be obtained direct from coal without converting it into oil.

June 4.—Dr. C. Anderson, president, in the chair.—C. **Hedley**: Differential elevation near Sydney. Two raised terraces of marine erosion situated on the ocean side of North Head are described. The highest is elevated about thirty feet. This pair of raised beaches again appears three miles to the westward. But there the highest is only about eight feet instead of thirty above the present level of erosion. The conclusion is drawn that this differential movement is the result of a fold or earth wave at least six miles wide and thirty feet high.—W. G. **Woolnough** and J. L. **Somerville**: A contribution to the geology of the Irwin River Valley of Western Australia. Two strongly unconformable Pre-Cambrian formations are distinguished. The well-developed Permo-Carboniferous system is zonally subdivided chiefly on a lithological basis. The glaciology is described in some detail. Reasons are advanced for regarding as Cainozoic (Plateau Beds) much of the formation previously described as Jurassic. Well-marked step-faulting towards the Indian Ocean is indicated. The probability of the existence of economically important deposits of coal and salt is considered remote.

Linnean Society of New South Wales, May 28.—E. C. **Chisholm**: Eucalypts of the Blue Mountains and their defined areas. Thirty-four species of Eucalypts have been observed by the author on the Blue Mountains and the distribution of those species in this region is recorded.—J. R. **Malloch**: Notes on Australian Diptera. No. ii. Notes on a number of species in the subfamilies Anthomyiinæ, Phaoniinæ, and Fanniinæ. Nine species are described as new, and a key is given to the three Australian species of Hylemyia.—R. **Veitch** and W. **Greenwood**: The food-plants or hosts of some Fijian insects. Part 2.—T. **Steel**: Observations on *Helix aspera* in Australia. This shell is usually considerably smaller and always lighter in weight in various parts of Australia and in New Zealand than is normally the case in Europe. It is identified with the var. *tenuior* Shuttl. Other varieties found near Sydney are vars. *depressa* Paul and *puncilulata* Bandon. A specimen distinctly approaching the cornute form was also found, but no sinistral examples have been met with. Marked diminution in size of the shell in the adult, following prolonged, dry, hot conditions, is noted.

June 25.—Mr. R. H. Cambage, president, in the chair.—W. Docters **van Leeuwen** and H. H. **Karny**: Two new thrips-galls and their inhabitants from New South Wales. Descriptions of the occurrence of *Euoplothrips bagnalli* on *Randia chartacea*, and of *Cryptothrips* (?) *intorquens* and *Euoplothrips bagnalli* on *Smilax australis*.—A. M. **Lea**: On some Australian Scarabæidæ. The paper deals with cockchafer beetles; notes on various species are given, and thirty-eight species, mostly of the subfamily Melolonthides, are described as new.—C. **Iredale**: Results of Roy Bell's Molluscan Collections. The collection here studied is only one of half a dozen made at important zoological points on and about the Australian coast for the purpose of elucidating geographical problems. The Twofold Bay Mollusca agree in species and genera with those from Sydney, but entirely lack a northern Australian element, and show a small percentage of southern Australian forms, a number of additions of such species being made to the N.S.W. fauna. A few new species were secured, while the fine series, in perfect condition, of many species have already furnished important results, such as the viviparous nature of some Turritellid molluscs and the polyphyletic nature of the Minolioid group of Trochoids. A most important feature of a few dredgings made in 50-70 fathoms is the g resemblance between the molluscan fauna at pre living at that depth and the fossils of the Upper of the Muddy Creek deposits.

VIENNA.

Academy of Sciences, June 12.—L. **Lämmerm** On the dispersal of warmth-loving plants in the district. Researches on the light- and climate-rela of the stone pine.—F. **Ris**: Odonata, describin species, two from the White Nile previously undescr —H. **Spandl**: Freshwater Amphipodes including t of the Caspian Sea and of Lake Baikal and of terranean waters, and a discussion of the migrati marine Amphipodes into fresh water.—V. **Brehm**: Entomostraca from the Handel-Mazzetti exped to China.—E. **Dittler** and A. **Kohler**: Experim researches on disentangling potassium-sodium fels Reactions of this sort have been recognised for K NaCl, but so far little has been done on the silic Diffusion in the solid condition can be shown to place in thin sections. Perthite was heated i electric resistance furnace for 500 or more hours temperature of about 1000°. After heating, the d ence in the refraction of the two components of per had completely vanished. The capacity of albite orthoclase to diffuse into each other at high tem tures, and whilst still solid, is favoured by the cir stance that these felspars can form mixed crystal

June 20.—**Kerner-Marilaun**: Solar-climatic peratures in palæozoic antiquity.—H. **Handel-M zetti**: Plantæ novæ Sinenses. More new plants China, varieties and species of Juniper, Cam Lobelia, and Leontopodium.—L. **Kolbl**: The tec of the granite peaks in the High Tauern.—R. **Kren** and R. **Gruber-Rehenburg** of Graz: Electrolytic ductivity in molten metal alloys, 6th communica Researches on the electrolysis of some copper allo CuZn, CuSn, CuAg, CuAl. In Cu-Sn a small placement of Cu to anode, of Sn to cathode somewhat greater displacement in Cu-Al, of C cathode, Al to anode.—R. **Kremann** and O. **Be** Electrolysis of Ag-Pb alloys, Ag to cathode, P anode.—R. **Kremann** and H. **Drazil**: On the influ of substitution in the components of binary solu equilibrium, 45th communication. The binary p diagram of benzhydrol with phenols and amines.- **Müller**: Calculation with Falt-products in its app tion to figures of the second degree in space. A method of calculation having the advantage of g brevity, particularly with complex quantities.

Official Publications Received.

Malayan Agriculture, 1924. Handbook compiled by the Depar of Agriculture, F.M.S. and S.S. (British Empire Exhibition ed Pp. v+301+iv. (Kuala Lumpur: Department of Agriculture.) 1s.

Agricultural Research Institute, Pusa. Bulletin No. 152: The Ex Morphology and Bionomics of the commonest Indian Tick (*Hyal cegyptium*). By Mohammad Sharif. Pp. 25+5 plates. (Calc Government Printing Office.) 1 rupee.

Report on the Administration of the Meteorological Department Government of India in 1923–24. Pp. 16. (Simla: Government P 2 annas.

Union of South Africa: Department of Agriculture. 9th and Reports of the Director of Veterinary Education and Research, 1923. Pp. 823. 10s. Reprint No. 18: Phosphorus in the Live Industry. By Sir Arnold Theiler, Dr. H. H. Green, and Dr. P. J Toit. Pp. 47. 6d. (Pretoria: Government Printing and Stationery O

Forestry in Brunei and Labuan: a Statement compiled for the B Empire Forestry Conference, Canada, 1923. By G. E. S. Cubitt. (Singapore: Government Printing Office.)

Federated Malay States. Report of the Secretary for Agricu Straits Settlements and Federated Malay States, for the Year Pp. 10. (Kuala Lumpur.)

United States Department of Agriculture. Department Bulleti 1223: The European Elm Scale in the West. By Frank B. He Pp 20. (Washington: Government Printing Office.) 10 cents.

Jamaica. Annual Report of the Department of Agriculture fo Year ended 31st December 1923. Pp. 39. (Kingston, Jamaica: Go ment Printing Office.)

Board of Education. Regulations for Whitworth Scholarships 52nd edition. Pp. 15. (London: H.M. Stationery Office.) 2d. net.

The Development of the Hokkaido Imperial University. Pp. plates. (Sapporo, Japan: Hokkaido Imperial University.)

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Editorial and Publishing Offices :

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

ditorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

elegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2861, VOL. 114]

The China Indemnity Bill.

CHINA is perennially a land of contrasts. This holds not merely in material things that strike the eye—such as nodding the head to say no, shaking it to say yes; putting on the roof of a house before laying its foundation; ending the book on the page where ours begins—but in spiritual things also, such as being content with an ethical system rather than a religion, but making its practice an inalienable part of the inner man. Nor does the spirit of contrast end here. It affects, to his surprise, the foreigner, and in particular the Englishman, who lives and works in China. Day by day in business matters he is inconvenienced by Chinese unpunctuality, by their waste of time, their avoidance of definite statement, their shrinking from responsibility, their superstitions; but when challenged as to the outcome of it all, he acknowledges, as recently a Consul-General did at a social gathering, that though he is at times annoyed or angry with them, yet when he thinks of the Chinese, he remembers mainly their honesty, their habitual courtesy, their good humour, so that liking and even affection becomes his ultimate attitude.

Another aspect of this spirit is presented by the *Times* of August 9, which includes both an article from a correspondent entitled "A Way to help China" and a leader on "Chinese Problems." The latter, while indicating how important to British trade would be even a slight improvement in China's present political conditions, supports the views expressed by its correspondent as to the value of co-operation, and declares "the line of action he proposes will lead to success. Others will mean confusion and failure." The contrast seen here amounts to this, that while our contemporary, by means of letters from its well-informed correspondent in Peking, has continuously pointed out the increasing antagonism, amounting even to danger to life, which foreigners at present experience in China, the article in question, which advocates as its one aim the cultivation of Anglo-Chinese friendship, is commended as being "an admirable and directly practical way of making British influence felt in China in its most fruitful form."

We now turn to the way there proposed for helping China: to devote to education practically the whole—or say nine-tenths—of the British quota of the Boxer Indemnity Fund, amounting to 400,000*l.* a year and payable until 1945. The article first directs attention to certain defects in the China Indemnity Bill, which in the House of Commons has passed its second reading and the report stage: its purposes are as yet indefinite, but an amendment, tabled in fact by members drawn from all three political parties, proposes that these

purposes, like those adopted by Japan and the United States in the same matter of indemnity remission, shall be defined as "educational or cultural." This amendment will probably be adopted, for Great Britain, pressed by both the United States and Japan in the Chinese markets, cannot afford to take a lower line, even in name, than they. In that case, the Advisory Committee which the Bill proposes to set up to advise the Foreign Secretary will have to be constituted accordingly, and should contain not only persons having knowledge and experience of educational and medical work, but also, in view of the great and increasing importance of female education, a Chinese woman, who, like her compatriot proposed to be included on the Committee, should favourably impress Chinese opinion by appropriate scholarship and educational experience.

To us, the article is of particular interest, because it boldly states that there is only one way to help China permanently and radically: that is, by education, and, moreover, an education which includes science. This assumes that no ground more favourable than education exists for the promotion and exercise of friendly relations between British and Chinese. The field includes, of course, such institutions and activities as universities, colleges and medical schools, and the promotion of scientific research in them and in related institutions. If the right method be adopted, it will be possible to bring home to the Chinese, who are both a shrewd and a responsive people, the value to China of including in the curriculum of higher education, as well as the study of science, that of letters, and of making it possible for Chinese youth to acquire some of the characteristics which mark the traditions of Public School education in England at its best—its spirit of initiative, of independence of character, of the desire for corporate well-being and voluntary service.

As there is only one way of radically helping China, so there is only one method of making this help permanent. The method is that of co-operation. This should be full and continuous, alike in formulating any general plan and in carrying it out in detail. To ensure that co-operation should be of this kind, at once real, and personal, and officially recognised, an indispensable condition is that an admixture of Chinese and British members should be an element in the constitution of the Foreign Office Advisory Committee, the local Committees in China, and the Boards of Management of all aided institutions, whether under Chinese or British management. This principle has been initiated and commended by the foresight of the Foreign Office in arranging for the inclusion on the Advisory Committee of "at least one citizen of the Republic of China." It remains to extend the p ciple and to apply it comprehensively. Local Educa Committees, which would act under such general r lations as the Advisory Committee will draw up, m be formed in each of China's eighteen Provin capitals, the Chinese and the British Chambers Commerce there each nominating one-third of members, the remaining third being partly *ex o* and partly co-opted or nominated. In the of Provinces not having a British Chamber Commerce, it would not be difficult, by nomina or co-optation, to provide the necessary third, s not more than four members at most would required. A similar method might be employe providing the admixture of representatives Boards of Management of higher educational ins tions, wherever situated.

The Advisory Committee as the central autho would itself deal with central institutions such as uni sities, and with central activities such as medical w scholarships, and Chinese students. As to t activities, it may be noted: that the Anglo-Chi community, in all their representations to the Br Government, have emphasised the high value British medical work, of which they are rightly pr that scholarships stand for the Chinese tradition which learning opens the way to distinction ar career; and that Chinese expenditure on stude which would involve a Chinese Institute in Lon and a subsidised hostel, would tend, by means mutual international intercourse and understand partly to open the world to China and partly to China to the world.

If some Anglo-Chinese critic should object that Chinese are not ripe for this equal hand of fellows the answer must be: first, that nothing is so uplif as this gesture, provided it be continued long enc to show that it is real; and next, that not even keenest detractor of China will deny the pervasive among her people of the characteristic of respons ness. In this the Chinese are faithful to the teach of their great sage, who, when Lao-Tzū challenged great maxim, "Return good for evil," by ask "With what then will you recompense kindness replied, "Recompense injury with justice, and rec pense kindness with kindness."

This then is the way to help China: by cultivat on both sides, the power to forget past injury; enabling each nation to realise, through real comprehensive co-operation in education, the characteristics of the other; and by both f accepting the truth that education, while it always a venture of faith, holds, as no other m ment does or can, the promise of the future.

Probability in Theory and Practice.

surances sur la vie: calcul des primes. Par Henri Galbrun. (*Traité du calcul des probabilités et de ses applications,* par Émile Borel. Tome 3: *Les Applications de la théorie des probabilités aux sciences économiques et biologiques,* fascicule 1.) Pp. vi+311. (Paris: Gauthier-Villars et Cie, 1924.) 35 francs.

ments de la théorie des probabilités. (Cours de la Faculté des Sciences de Paris.) Par Prof. Émile Borel. 3e édition revue et augmentée. Pp. vii+226. (Paris: J. Hermann, 1924.) 18 francs.

THE treatment of the subject of probability has developed in recent years mainly in its application to statistical research, and a large amount of work has been produced in attempts to express frequency distributions or correlation surfaces in mathematical forms or in measuring correlations and periodicity. In all these researches a practical object was to be attained, and there is almost unlimited scope for further development, but there still remain two classes of books on probability, which are exemplified by Prof. Borel's "Elements" and Dr. Galbrun's actuarial text-book, which are but slightly connected with modern statistical work.

Prof. Borel's book is an excellent example of the treatment of probability which begins with games of chance and drawings from urns; it leads, through the approximations to factorials, to the normal curve of error. Prof. Borel discusses geometrical problems, shows the Gaussian treatment of errors of observation, gives Bayes's theorem, and then indicates the promised land of statistical investigation and tells us of some of the many fascinating places we may find there. But he leaves us, as it were, at Mount Horeb. The book is already known in its earlier editions as a good text-book on the subject within the limits indicated, but it ends at the point where many modern readers begin to be most interested.

Dr. Galbrun's subject, in some respects, begins after the interest of most readers has expired, for actuaries are bound to assume that they know the probabilities of death in order to make their calculations, and modern work has been mainly concerned in finding ways of interpreting the statistics on which the probabilities are based. Unlike the well-known English text-book writers, however, Dr. Galbrun attempts to bridge this gap, as he discusses the "errors" involved in some of the probabilities, endowments, and annuities with which he deals, and it is this part of his work that calls for special comment. In statistical work it is customary when calculating a coefficient of correlation, or a mean, or some other function, to set out after the result the probable error of the figure reached as some indication of the deviations that will arise in such cases, and the natural course would appear to be to adopt some such method in dealing with the values that an actuary requires. The matter is, however, more complicated than that of the means to which we have referred. There are not only the deviations that arise in the original statistics, but also, even if the true probabilities of death in the future were known, there would be deviations from these probabilities just as there are deviations from the probability of a head falling in a coin-tossing experiment where the probability is known. Dr. Galbrun does not attempt to give the probable errors of various actuarial functions, but makes estimates of what we may call a "safety margin" which will cover 99 per cent. of the cases. This margin could, in theory, be used as a loading to the premiums charged, but if it were used for small classes of business it might, by increasing the premiums, reduce the amount of business and so render the loading insufficient on the theory adopted. Any such loading must, in practice, be regarded somewhat broad-mindedly, and Dr. Galbrun has not striven after extreme accuracy but has used rather rough approximations.

We may now turn for a moment to some other points in the work. In many ways it follows familiar lines, with an unfamiliar notation, and the methods of working out the values of annuities, assurances, and premiums require little comment. We are a little surprised, however, to find that in the evaluation of certain complicated benefits, Lubbock's formula is used, so that a number of differences have to be calculated and the arithmetic becomes troublesome. The customary method in Great Britain of using Simpson's or some similar rule seems preferable. In a few cases, also, Dr. Galbrun spoils his effect a little by using an approximation when an accurate result presents no real difficulty, and we would willingly have given up some of the work on survivorship annuities for a concise treatment of apportionable annuities.

The book concludes with an appendix of thirty pages discussing mathematically the application of the law of error to the probabilities of death, and in this connexion we would throw out a word of warning. The probability of dying in a year at the ages that are most important in practice are small (they are less than 0·02 at ages under 55), and when the probabilities become relatively large, as in extreme old age, the number of cases becomes small. It follows, therefore, that the normal curve of error should only be used with a certain amount of discretion. Partly, no doubt, owing to the series in which the particular volume is included, and partly, possibly, owing to Dr. Galbrun's

personal inclination, his book is more mathematical and less clearly identified with the business of life assurance than the English text-books. The actuary on the Continent is less obviously the man of business than the actuary in England.

As we have seen, Prof. Borel indicates at the end of his book the interesting developments which lie outside its scope; it is not belittling, but appreciative, to say that there is room for similar development beyond where Dr. Galbrun's book ends, and that comparatively little has yet been done.

Electrical Instruments.

(1) *Electrical Measuring Instruments.* Part 1: *Commercial and Indicating Instruments.* By Dr. C. V. Drysdale and A. C. Jolley. Pp. 440. (London: Ernest Benn, Ltd., 1924.) 55*s.* net.

(2) *Electrical Vibration Instruments: an Elementary Text-book on the Behaviour and Tests of Telephone Receivers, Oscillographs, and Vibration Galvanometers.* (Engineering Science Series.) By Prof. A. E. Kennelly. Pp. xi+450. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 30*s.* net.

(1) IN the preface to their book on "Electrical Measuring Instruments," the authors state that "some apology would seem to be necessary for issuing yet another book on electrical instruments." It is true that a certain number of books of varying merit have appeared within the last few years, but the authors need be under no apprehension as to the need for the book which they have just published.

A book on electrical measuring instruments such as that which has been produced by Messrs. Drysdale and Jolley is of permanent value. It contains a fund of information about their design, the materials used in their manufacture, and the precautions that should be taken to secure accuracy, which will render it of very great value to instrument makers and electrical engineers. If one tests the book by looking for information on the less-known instruments, one seldom fails to find it. The only serious criticism which may be offered is the comparatively meagre information given about the qualities of cobalt steel. This material is being used in increasing quantities in Great Britain, and a large amount of research work on it has been carried out within the last few years.

The volume opens with a short account of the general principles involved in the measurement of electrical currents. The second chapter deals with mechanical design, and the various types of ammeter, voltmeter, and wattmeter are classified in accordance with their methods of control. Much useful information is given on such subjects as the properties of cylindrical spri and the arrangement of damping vanes. There is interesting note on pivots and on the methods manufacturing them to ensure good wear. In t and the following chapters such matters as the mounti of the series resistances of voltmeters, the design reactances for minimum power factor, the constructi of condensers with zero temperature coefficient, t methods of constructing pointers and scales, and leading in the conducting wires to instruments, discussed with great care and thoroughness. It the study of points like these that makes the differe between a good instrument and a bad one. Chap. deals with the quickness of action of instrumen and the considerations in the design that are importa from this point of view; fundamental electrostatic a magnetic theory is discussed, and among other matt the legal definitions of the units of current volta and resistance are included, and also some elabor tables of the working constant of instruments ma by different manufacturers.

One of the most useful parts of the book is Chap. which deals with the properties of electrical materi After a general account of the ordinary materials u as conductors, and those employed for insulating wir some figures are given for the most suitable curr densities to use in ammeter coils, and for the resi ance per volt in voltmeters. The thermo-elect properties of alloys are discussed in detail, and the p perties of the material known as "Therlo," which h been produced in the United States as a substitute manganin, are included. Some interesting data given of the dielectric strength and insulation resista of dielectrics. Evershed's well-known work on the eff of moisture on insulation is dealt with, as well as less-known work of Thornton on dielectric constan No account of insulating materials nowadays is compl which does not give some data relating to bake and its derivatives, and a good deal of information to be found about it, as well as about bitumen a impregnating materials. In dealing with magne substances, some useful data are given of the Heus alloy, including its hysteresis loss for a good range flux density. Yensen's vacuum iron is mentioned, a figures relating to it are given. The remaining chapt of the book deal with the properties of the princi types of instrument, namely, moving coils instrume soft iron instruments, dynamometer types of vo meters, ammeters, and wattmeters, hot-wire inst ments, and electrostatic instruments.

The figures and tables that are included in th chapters must have involved careful and elabor research, both in obtaining the necessary data a in classifying them. They provide a very valua

compendium of information about present-day instruments.

This book should be on the shelves of all electrical engineers and instrument makers.

(2) Dr. Kennelly's work on telephone receivers and other vibrational instruments is well known, and his method of considering the characteristics of telephone receivers as reciprocating electric motors has been widely recognised. He says in the preface, "The basic idea in the subject-matter is that every electrical transformation instrument possesses a motional impedance diagram, which is its fundamental form and is capable of disclosing many electro-mechanical characteristics of the instrument."

The book starts with an account of the Bell telephone receiver, and describes the various types which are now being manufactured. A considerable part of the subject-matter in the following chapters describes the researches Dr. Kennelly and his assistants have made on the vibration of the telephone diaphragm, and the reproduction of these papers into a book will be of great value to those who are interested in this subject. Nowadays, when the clear reproduction of speech and music is occupying the attention of so many people interested in broadcasting, the book should be of special interest. Not only does Dr. Kennelly deal very thoroughly and completely with the telephone receiver, but his book also contains a very good account of the various forms of vibration galvanometer which are now in use in light-current laboratories, as well as many of the different forms of oscillograph. In this connexion the oscillographmeter which Dr. Kennelly has devised is described. All those who are interested in light-current electrical measurements and the development of the telephone will find that this book is a necessary addition to their libraries.

Mendelian Studies.

Studia Mendeliana: ad centesimum diem natalem Gregorii Mendelii a grata patria celebrandum. Adiuvante ministerio Pragensi edita. Pp. 415. (Apud "Typos," Brunae, 1923.) 50 Kč.; 1½ dollars.

THE centenary of the birth of Gregor Mendel was celebrated at Brunn in 1923 by an international meeting of biologists. In "Studia Mendeliana" are collected twenty-four papers written in honour of the occasion. The inclusion in this volume of several papers on general evolution, of others on cytology, anthropology, the evolution and inheritance of sex, and lastly on the transplantation of tissue in relation to specific difference, illustrates the variety of the modern developments which have grown out of Mendel's fundamental discovery.

Among the papers on evolution is one by Prof. Lotsy on the importance of hybridisation in the production of new forms both in Nature and among domesticated races. Prof. V. Haecker writes on the origin and classification of racial characters, and advocates a close analysis of their occurrence in related forms from an evolutionary point of view. Prof. Witschi discusses the theory of orthogenesis, specially in relation to the evolution of sex. He regards sex differentiation as forming an orthogenetic series, culminating in forms with complete sex differentiation and determination at the reduction division. But the coincidence between sex determination and the reduction division is unessential, as shown by haploid and diploid hermaphrodites in animals and plants. From Witschi's own experimental work on rudimentary hermaphroditism and sex inheritance in local races of Rana, he concludes that they represent stages in the passage from the hermaphroditism of the Chordata to the highest forms of sex differentiation and determination at the reduction division. Differences between the local races of Rana he attributes to quantitative changes in the sex genes, brought about by indirect action of external conditions—an interpretation closely akin to that of Goldschmidt in his work on inter-sexes in Lymantria.

Working on Drosophila, Prof. Mohr has found a new case of the interesting phenomenon named by Bridges "deficiency," this term indicating the loss or inactivation of a section of a chromosome involving several genes. Hitherto such cases have been found only in sex-linked characters, but here the second chromosome is affected. Mohr makes the suggestion that all the dominant mutations in Drosophila which are known to be lethal when homozygous may turn out to be due to "deficiency." A report on the progress in the cytological and genetical investigation of the genus Crepis is made by Babcock, Collins and Mann. It is remarkable that the cross between *C. setosa* with four pairs, and *C. biennis* with twenty pairs of chromosomes, has given a hybrid with twenty-four pairs of chromosomes, and this hybrid has proved to have some degree of fertility. The authors regard this as an indication that more than one pair of homologues exist in the *C. biennis* group.

Dr. W. E. de Mol writes on heteroploidy and cross-fertility in *Hyacinthus orientalis*. He found both diploid and heteroploid forms to be self-sterile, but cross-fertilisations in general gave good seed. Heteroploid forms frequently arise as bud sports on diploids, and it is of special interest that these will not cross with the forms from which they derive.

In her essay on the transplantation of living tissue, Frl. Erdmann discusses the work of Leo Loeb on the

"individual differential" in newly-born rats and guinea-pigs of known breeding. Loeb found that the closer the relationship the more successful were the transplantations. The slightest difference in relationship affected the results, even brother to brother transplantations being more successful than those from parents to children. From the work of Spemann it is known that such individual distinctions arise during the development of the embryo, and Erdmann and others have suggested a parallelism with interspecific fertility. Nevertheless, Loeb has shown that in *Rana temporaria* these distinctions are independent of, or subsidiary to, the specific differential. Of great interest is Erdmann's observation that interspecific transplantations in Rana are facilitated by an intermediate period of growth of the graft in various media. C. P.

Oceanography.

An Introduction to Oceanography: with Special Reference to Geography and Geophysics. By Prof. James Johnstone. Pp. xii+351. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1923.) 15*s.* net.

OCEANOGRAPHY is an extraordinarily composite subject; it touches on almost every branch of science, from the astronomical theory of the tides to the biological significance of the plankton. For this reason it is difficult for the student to weld the very varied facts at his disposal into a single consistent body of knowledge. Herein lies the value of a book such as this, which brings out the general theory in a clear and very readable manner without unnecessary detail.

After a brief description of its morphology, the probable origin of the world-ocean is discussed. This leads naturally to the consideration of its depth and the character of the bottom and the nature of the ocean margins. Great stress is rightly laid on the very small vertical scale of the surface features of the earth. Two chapters then follow on the chemistry and physics of sea-water. In the chapter on the tides, the author has attempted with very fair success the difficult feat of a non-mathematical exposition of the theory of their production. The oceanic circulation is described and explained very clearly, so that the significance of the underlying causes can be fully appreciated. The final chapter on secular changes in the ocean is perhaps the most interesting and suggestive, and fixes in the mind the ideas put forward in the rest of the book.

When so wide a field is covered it is almost impossible for the standard to be maintained throughout. The chapters on the chemistry and physics of sea-water are not quite so good as the rest of the book. In the section on the hydrogen ion concentration of sea-water, the notation has been confused, the symbol pH h used at first (p. 149), where it is obvious that the hydr ion concentration, C_H, is referred to, although " pH " is correctly defined and expressed (p. 153). the description of the effect of cooling a solutio sodium chloride (p. 185) it is incorrect to say " The quantity of ice formed increases, the quanti sodium chloride crystals formed also increases and concentration of the solution remaining unfr increases." As the eutectic is approached, *either* ice or pure sodium chloride crystals separate accor to the initial concentration of the salt. Not until eutectic is reached do salt crystals and ice separate together (*vide* "A System of Physical Chemist vol. ii., W. C. McC. Lewis, pp. 247 and 248).

The explanation on page 186 of why ice formed sea-water floats is strange. The expansion of w on solidification has been overlooked. The ice for from sea-water is not only lighter than sea-water is lighter than fresh water, since its specific gra is about 0·92 (*vide* "Handbuch der Ozeanograp Band I., Dr. O. Krümmel, p. 507).

Apart from these sections the book is excellent, it is hoped that they will be revised in the next edi The illustrations are well done, and there is a appendix which can be referred to for literature. T are few misprints; the formula at the top of p. should read "$Q = P.K/T$," and on p. 191, line " more" should read "less," while on p. 187 "Na should read "Na_2SO_4."

Our Bookshelf.

(1) *Outlines of Fungi and Plant Diseases: for Stu and Practitioners of Agriculture and Horticulture.* F. T. Bennett. Pp. xi+254. (London: Macm and Co., Ltd., 1924.) 7*s.* 6*d.* net.

(2) *Practical Botany.* By Rai Bahadur K. Rangac Pp. iii+114. (Madras: Government Press, 1 18 rupees.

(3) *British Mosses and How to Identify Them.* J. H. Crabtree. (How to Identify Series, No. Pp. 63. (London: The Epworth Press, 1 1*s.* 6*d.* net.

(4) *Plant Studies.* By Prof. James A. Todd. (Fou tions of Nature Study Series.) Pp. 151. (Edinbu A. Baxendine and Sons, 1924.) 2*s.* 6*d.* net.

(5) *The Nature-World of London.* By Walter Johr 1: Trees and Plants. Pp. viii + 118 + 8 pl (London: The Sheldon Press; New York Toronto: The Macmillan Co., 1924.) 3*s.* net.

(1) Mr. Bennett's book on fungi and plant dise has been written more particularly for student agriculture and horticulture. It should serve purpose very well. The first part gives a ger account of the fungi, with a short classification the life histories of a number of members of the var groups. The second part deals with plant disease

sch. The modern study of this subject only began bout 1866, but has developed in many aspects in cent years. The chapter dealing with the general pects of parasitism, such as infection, resistance, and munity, might very well have been considerably tended. In later pages all the better known fungus eases of crops, from mycetozoa to rusts and bacteria, e clearly described, together with their effects on e host plant and methods of treatment. In conxion with wheat rust, the important developments ce the "bridging" theory was generally held are ly referred to in a footnote. The volume will be eful to all those who wish to acquire a general knowlge of plant diseases. Its conciseness and arrangent will appeal to the student.

(2) The second work on our list is a small book laboratory exercises to accompany the author's Manual of Elementary Botany for India." The ants studied and illustrated are chiefly tropical forms ch as *Dolichos lablab*, *Arachis hypogæa*, and *Andropogon sorghum*, which are not generally examined in uropean laboratories. The figures, many of which e photomicrographs, would have been clearer in some ses if they had been taken with a higher magnification. he book is in three sections, the first dealing with the orphology of root, stem, leaf, flower, and fruit; the cond with physiology, in which various simple periments are outlined; and the third with Cryptoms.

(3) The author gives in small space popular descripons of about sixty of the commoner British mosses. n each page two species are described, with photoaphs of the species on the accompanying page. echnical terms are avoided, but habitats, and in some ses localities, are given. This popular treatment ould enable moss-lovers to recognise genera, and in any cases species, without much difficulty. The notographs usually show the habit without attempting to portray any further detail.

(4) Mr. Todd's book is one of a series on the foundaons of nature study. It is intended for teachers who e conducting school classes in this subject. Beginning ith a short chapter on the cellular structure of plants, ere follow others equally brief on the various plant gans, vegetative reproduction, plant identification, ees and cryptogams, with a final chapter of notes on ology. The definition of a flower (p. 53) is not very appy, and some of the figures suffer from their small ze. Those who have had no previous acquaintance ith botany would find it of greatest use.

(5) The charmingly written little book of Mr. Walter ohnson is full of lore concerning the trees and other lants of the London area, as they are known to the uthor. Botanist and layman alike can find entertainent in its pages. The historical trees referred to nclude Nelson's mulberry and Captain Cook's "cotton ree," which is a balsam poplar. Chapters on the wild owers and weeds of London are equally entertaining ccounts of plants found in the commons, gardens, and pen spaces of London. In the final chapter on ondon's mushrooms and toadstools, many of the ommon forms are mentioned, including some of those ound in wine cellars. It is to be hoped that the uthor's promise of a further volume on other phases f Nature in London will be carried into effect.

Kitāb al-'ilm al-muktasab fī zira'at adh-dhahab: Book of Knowledge acquired concerning the Cultivation of Gold. By Abu'l-Qāsim Muḥammad ibn Aḥmad al-'Irāqī. The Arabic text edited with a translation and introduction by E. J. Holmyard. Pp. iv+62+53. (Paris: Paul Geuthner, 1923.) n.p.

MR. HOLMYARD in the introduction to his book remarks justly that "the investigation of the original sources of Arabic chemistry has scarcely yet been attempted." The most important work was that of Berthelot, yet owing to the limited range of works studied, particularly in the case of Jabir ibn Hayyān, it is likely that some of the conclusions of the great French historian of chemistry may require modification. A reaction against the rather premature generalisations of Berthelot, which are most warmly supported by those who have no knowledge of the original sources, has undoubtedly set in, and the further investigation of Arabic sources by those competent to undertake the work will no doubt provide information of great interest to students of the history of chemistry.

The text published by Mr. Holmyard is a small treatise by a thirteenth-century Arabic alchemist. The intrinsic interest of the work is not very great: the theory that all metals are really the same and differ only in unessential properties, which may be removed, is Aristotelian, but the assumption that "the metallic substance freed of such accidental properties is gold" seems unusual, and, as Mr. Holmyard says in his introduction, was opposed by other Arab chemists, including Ibn Sina ("Avicenna"), who held that each metal is distinct. The author speaks of the "two leads," the "two coppers," and so on; some materials will "turn copper yellow with the yellowness of gold," but "do not make it complete." As the Latin Geber says, *tutia* will "citrinise copper of a good yellowness," but he adds that it is to be taken only for "the lesser work," *i.e.* for deception only. The comparison of the elixir, which is to transmute metals, with the remedy, which is to cure disease, is instituted. Many names of Greek-Egyptian alchemists, such as Zosimus, Agathodemon, Maria, etc., are mentioned: the first as "the Jew"; Khalid ibn Yazid and Marianus also appear. The "Art of the Egyptians" is chemistry. All this points clearly to the sources: Arabic chemistry came from Hellenistic Egypt in the first instance, and one of the important questions to which further research will disclose an answer is how much original work the formerly much vaunted Arabic alchemists really did.

Mr. Holmyard must be congratulated on his book, and readers will look forward to the conclusions he will perhaps draw from the study which has enabled him to produce it. Of the Arabic text the reviewer is unable to offer an opinion, but it has been looked through by Prof. Browne and Mr. Steele, who are experts.

J. R. P.

L'Hérédité. Par Prof. Émile Guyénot. (Encyclopédie scientifique: Bibliothèque de Biologie générale.) Pp. 463. (Paris: Gaston Doin, 1924.) 19·80 frs.

THE scientific experimental study of heredity may be said to have begun with the present century. The views of the early hybridisers were too vague, and were based upon results too varied and indefinite to lead anywhere. Moreover, the work of the nineteenth

century was required to build up an edifice of knowledge concerning organic structure and development, the nature of sexual reproduction, and the structural basis of heredity, before definite views of the laws of inheritance could be propounded and accepted. But in the last twenty-four years advance has been rapid, because all these and other lines have converged upon the solution of the central problem of heredity. Where all was formerly hazy and nebulous, results are now seen to be clean-cut and precise, continually opening up further vistas of understanding concerning the relations between the details of organic structure as we find them, and the laws and exceptions to the laws of inheritance as they are developed by experimental work.

While the advances in Mendelian heredity, sex chromosomes, etc., have been rapidly incorporated into biology on account of their fundamental character, yet to the lay mind heredity remains for the most part an unintelligible and almost mystical "force." Even the medical profession remains in an uninstructed condition regarding a subject which vitally concerns their daily activities.

Any book which spreads the modern knowledge of heredity is therefore to be welcomed, and the volume before us, by Prof. Guyénot, should be very useful in this respect for French-speaking peoples. The author's definition of heredity is worth quoting: "L'hérédité consiste dans la totalité des réalisations morphologiques ou physiologiques que le descendant tient de ses parents."

The volume is divided into three sections. The introduction begins with a chapter on the continuity of living matter as the basis of heredity. The sections deal with the laws of hybridisation, the chromosome theory of heredity, and Mendelian anomalies. In the last, such topics as hyperdactyly in fowls, lethal factors, cytoplasmic inheritance, and xenia are discussed. The final chapter is devoted to inheritance in man. While containing little or nothing that is new to the geneticist, the book presents a useful summary of recent advances in this field. The number of Drosophila mutations has now reached more than 300, not 100 as the author states. R. R. G.

Human Protozoology. By Prof. Robert W. Hegner and Prof. William H. Taliaferro. Pp. xix+597. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1924.) 4.50 dollars.

THIS work has been prepared primarily for the use of students in the authors' course of protozoology in the School of Hygiene of the Johns Hopkins University, but it will be of great use to students pursuing similar courses in other institutions, and to medical officers who desire a concise statement of the facts of protozoology. Emphasis is rightly laid on the value of a study of parasites from lower animals, which are often more easily obtained than the allied species occurring in man, and serve as excellent material for practice in technique and in the study of life-cycles.

In the general introduction to the organisation of the protozoa, structure and modes of division are considered. The following chapters deal in turn with the main groups of protozoa, the structure and life-history of representative genera and species being described and careful reference made to the methods of spread those which occur in man. A chapter is devoted the genetics and the physiology of reproduction in t protozoa, and a final chapter gives useful informati on the diagnosis of intestinal protozoa. A well-chos list of books and memoirs on protozoa occupies sor fifty pages, there is an adequate index of authors a of subjects, and the volume is excellently illustrat by clearly drawn figures.

In reviewing a work which is so well done it is almo ungracious to ask for more, but here and there t authors might consider whether in their next editi they could add a few further details; *e.g.* in the chapt on Hæmosporidia (exclusive of malaria) it would useful to have some account of the life-history of Pir plasma, incompletely known though it be, and *Theileria parva*, a short account of Proteosoma, and reference to Mrs. Adie's work on Hæmoproteus.

The authors are to be congratulated on the produ tion of this excellent manual.

A Check-List of British Birds: With a Short Accou of the Status of Each. Compiled from "A Practic Handbook of British Birds." By H. F. Witherb Pp. 78. (London: H. F. and G. Witherby, 192 3*s.* 6*d.* net.

ORNITHOLOGISTS will welcome this little book, which printed on one side only of the paper for convenien in labelling or for the making of notes. The fact th it is taken from the "Practical Handbook of Briti Birds" is a sufficient guarantee that it is up-to-date a correct in all matters ornithological and nomenclatori

From the biological point of view, it is very i structive to look down the pages of the book and no which of the species remain binomial, which have r into trinomials. The latter, of course, are in the gre majority—a sign of the enormous amount of ge graphical variation which patient research reveal The problem is to understand why some species sho this tendency to break up into geographical races subspecies, while others remain invariant. The la of variability in some of these may be apparent onl due to our ignorance; but this cannot be true of t Chough, the Snow-Bunting, the Brambling (the specif name of which, by the way, contains a misprint), t Meadow-Pipit, the Waxwing, the Lapwing, the Redwin and many others. Sometimes whole groups, such the Tits or the Wheatears, seem to show excessi variability, while the Anseres contain an unusual large proportion of "unsplit" species.

The evolutionary biologist should pay more attentio to the rich mine which the labours of the systematis most notably in the group of birds, have opened u for him. J. S. H.

Exercises on Ordnance Maps. Selected and arrange by C. H. Cox. Pp. 60+12 maps. (London: G Bell and Sons, Ltd., 1924.) 1*s.* 9*d.*

ELEMENTARY and advanced exercises are based o twelve sections of different scale ordnance maps various styles. Concentration on map work of th nature is the best introduction to the study of geography Even if some of the questions are a little far-fetched a exercises on the maps, the book is excellent and deserv to be widely used in schools. R. N. R. B.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

On the Vibrations of Air in Organ-Pipes of Unusual Shapes.

IN 1867–68, when I was Principal of La Martinière College, Calcutta, I made some experiments on organ-pipes in conjunction with the Cathedral organist, Mr. Frye, who was trying to rebuild a small organ on which to practise in his own room. His problem was how to get pedal-tones from pipes smaller than the regulation minimum, namely, 8 ft. stopped diapason, a very inconvenient size in an ordinary house. I studied his "Hopkins and Rimbault," and became quite fascinated with the subject, chiefly on its scientific and mathematical side.

Mr. Frye supplied the first hint for a solution of the problem. He noticed how low were the tones given by a large bottle with a small neck, when blown across the mouth like a flute. For example, a bottle which stands easily in a space 1 ft. high on a base $4\frac{3}{4}$ in. in diameter gives the note Bass E♭, the pitch of an open diapason pipe about 6 ft. 8 in. from mouth to top. But the practical difficulties in the way of making a pedal "bottle-stop" proved too much for him.

I found my available text-books useless, and had to invent the mathematical investigation for myself. A "bottle-pipe" is really two pipes of unequal diameters, joined together by a flange from the outer edge of the smaller pipe with the mouth-piece, to the inner edge of the larger stopped pipe. The text-books give the formulæ of vibration in a uniform cylinder, either open or stopped. I took these formulæ for the two separate parts, and made them fit at the junction by the two conditions, that the air-pressures must be the same for both, and that with each swing the volume of air thrown from the small part into the large must be equal to the volume returned by the large into the small. Hence I deduced the formula

$$\tan mh \,.\, \tan mk = \frac{\text{area of mouth-part}}{\text{area of stopped part}} = \frac{r^2}{R^2},$$

where h and k are the lengths of the two parts, r and R their radii, and m is proportional to the vibration-rate of this composite pipe, so that $ml = \pi$, if l be the length of the open diapason of the same pitch.

This formula shows that h and k are interchangeable, so that the mouth-part may be short and the stopped part long, or the reverse, without altering the pitch. It is also easy to see that the lowest note will be obtained by making the two parts of the same length. This form gives us a new kind of organ-pipe which I call a *Bicylindron*. If r be the radius of the mouth-part, and R that of the stopped part, and h the length of either half, then

$$\tan^2 mh = \frac{r^2}{R^2} \text{ or } \tan mh = \pm\frac{r}{R},$$

where as before $ml = \pi$ gives the length l of the "tone," as estimated by organists; *i.e.* Bass C = 8 ft. tone; Tenor C = 4 ft. tone, etc.

That the above formulæ are accurate enough for practice I have proved by making zinc models with suitable measurements.

It can easily be seen from this formula that a *Bicylindron* "stop" can be made of two varieties. If $r < R$ the pitch will be lower than that of a stopped diapason of the same total length, $2h$. If $r > R$ the pitch will be higher; but it will be lower than that of an open diapason of length $2h$. For a pedal-stop, of course, r must be less than R.

But "Hopkins and Rimbault" gave another solution. There is an organ in Oxford, with a *Pyramidon* stop, invented by Ouseley. Each pipe is an inverted pyramid, closed at the base, with a mouthpiece at the narrow end, near the apex. The writer is astonished at the low note such pipes give in comparison with their height; but he attempts no explanation of the mystery. To the mathematician such a pipe is merely a conical pipe, closed at the broad end. My copy of Besant's "Hydrodynamics," said not a word about conical pipes, though almost all reed-pipes in an organ have open conical resonators. So I had to invent the theory for myself, and found out the formula, which gives the fundamental note and the overtones, namely,

$$\tan mh = mk,$$

where h is the distance from mouth to base, and k from vertex to base, m having the same meaning as before. I verified this formula by a few small zinc models. It is not given in Basset's "Elementary Hydrodynamics" (1890), nor in Lord Rayleigh's "Theory of Sound" (1894). The latter works out the theory of open conical pipes, and shows that they are, in pitch and in harmonics, equivalent to cylinders, as organ-builders know by experience. Basset perversely limits himself to conical pipes *without any mouthpiece*; so that his investigation is useless for the *Pyramidon*. But I have worked out the problem from the data given by both authors, and deduced from either the formula given above. Both authors give the formula for the mouthless pipe, namely,

$$\tan mk = mk,$$

which is merely a particular case of my formula, when $h = k$; *i.e.* when the mouthpiece is run down to a mere point at the vertex.

From the formulæ given above, mathematical readers can prove that, space for space, a *Bicylindron* always beats a *Pyramidon* for depth of pitch. For example, if the breadth at the stopped end be 9 inches for both, and the breadth at the mouth 3 in., and the height from mouth to stopper be 2 ft., the *Pyramidon* gives nearly a $6\frac{1}{2}$ ft. tone, while the *Bicylindron* gives a tone rather lower than $9\frac{2}{3}$ ft.

But the all-important consideration has not yet been noticed. In an organ everything depends upon "quality of tone"; and it is now an established axiom that quality of tone depends upon the proportionate admixture of harmonic overtones. The standard musical instruments—violin, piano, and organ—all give the complete series of natural musical harmonics, the vibration-rates of which are proportional to the series

1, 2, 3, 4, 5, etc., *ad infinitum*.

There is one exception in the organ. The stopped diapason can give only the odd harmonics, 1, 3, 5, 7, etc. The octave harmonics, which make the tone bright and clear, are all cut out. Thus a stopped diapason can give a soft sweet tone, but can never give the full rounded ring of the open diapason. Its chief advantage is that it takes up only half the space and saves half the cost in materials.

Now the formulæ given above prove that the overtones of a *Pyramidon* are all incommensurable and therefore unmusical. The best voicer in the world can make nothing out of it beyond a dull humming note. But with the *Bicylindron* all we have

to do is to make the ratio $r : R$ exactly equal to $\tan \pi/n$, where n is any integer, and we shall get the harmonic sequence

$$1,\ n-1,\ n+1,\ 2n-1,\ 2n+1,\ 3n-1,\ 3n+1,\ \text{etc.}$$

For pedal notes the best values of n are 5, 7, or 9; these will give octave harmonics. If we take $n=5$ we shall get a pipe shorter than the stopped diapason of the same pitch in the ratio of 4 : 5; but its harmonic overtones will be the series

$$1,\ 4,\ 6,\ 9,\ 11,\ 14,\ 16,\ \text{etc.},$$

which should give a far better quality than the ordinary stopped diapason.

But the best of all for quality is the $\pi/3$ *Bicylindron*, the length of which is two-thirds that of the open diapason of the same pitch. This pipe has the harmonic sequence

$$1,\ 2,\ 4,\ 5,\ 7,\ 8,\ 10,\ 11,\ 13,\ 14,\ 16,\ \text{etc.}$$

This pipe, if properly voiced, should make a solo stop with a unique loveliness of tone. Experimentally I have proved the sequence 1, 2, 4, and 5.

I worked out my formulæ in the case of a double conical pipe, made of two cones joined together at the broader equal ends, each tapering to a smaller mouth in opposite directions. The result can be found by a very pretty calculation from the formulæ given by Basset or Lord Rayleigh; it is

$$m \sin m\mathrm{H} = \left(\frac{1}{k}+\frac{1}{k'}\right) \sin mh \sin mh',$$

where $\mathrm{H}=h+h'$; h and k have the meaning given above for the *Pyramidon*; h' and k' the corresponding quantities for the second cone; and m gives as before the vibration-rate of the whole pipe, which is of lower pitch than an open cone of the same length. This double pipe is intended for reed-stops, which need a cone tapering to the narrow reed-tube. By taking $h'=h$ or $h/2$ we can get all the harmonics of the open cone h'; and by giving suitable values to k and k' we can ensure that the fundamental tone shall be an exact double octave below the open cone h', thus gaining the conditions for good quality. Hence we find in either case

$$\frac{1}{k}+\frac{1}{k'}=\frac{\pi}{2h}.$$

In 1868 I made four pipes on this plan, using some harmonium reeds I had by me, of pitch Tenor C, D, E, and F. Mr. Frye tried them in the Cathedral organ. We both agreed that the tone was very beautiful, when it came on. But there was a distinct burr at the beginning and end of the tone, and the pipes were so "slow of speech" that in a quick run they never spoke at all. Such "free reeds" are probably inappropriate: they are never used by English organ-builders. But the experiment shows that in expert hands a reed-pipe of this kind might be made with a tone of unique beauty, free from all defects of "speech."

JAMES A. ALDIS.

The Quantum Theory of Dispersion.

IN a recent letter to NATURE (May 10, p. 673) Dr. Kramers advanced a quantum theory of dispersion which is a generalisation of the theory of Ladenburg. The formula proposed by Kramers for the polarisation of an atom when put in a wave is his formula (5). This formula is stated by Kramers to satisfy the condition demanded by the Correspondence Principle, namely, that the dispersion due to an atom in a state of high quantum number is the same on the classical and on the quantum theories.[1] The presence of the second term has been introduced by Kramers for this purpose. From the point of view of the virtual oscillators of Bohr, Kramers, and Slater, the second negative term of Kramers is somewhat dissatisfying because an oscillator would give rise only to a term of the first positive type.

The present writer has been also considering the question of interaction between radiation and quantised atoms in connexion with the question of the Brownian movement of atoms in black body radiation. A picture similar to the virtual oscillator finds application also in that field. However, the exact form of the interaction has been conjectured by the writer to be somewhat different from that proposed by Kramers.

The difference can be illustrated in the case of a linear oscillator. In this case the expression of Kramers becomes at long wave-lengths

$$P=[n-(n-1)]\frac{e^2}{m}\frac{1}{4\pi^2(\nu_i^2-\nu^2)}=\frac{e^2}{m}\frac{1}{4\pi^2(\nu_i^2-\nu^2)}.$$

The same result may be also derived as

$$P=[\tfrac{1}{2}+\tfrac{1}{2}]\frac{e^2}{m}\frac{1}{4\pi^2(\nu_i^2-\nu^2)}.$$

In this manner the negative term may be avoided. In order to satisfy the Principle of Correspondence the dependence of P on ν must be in general slightly more complicated than that for the oscillator. This dependence can be derived from a consideration of a "virtual orbit" rather than a virtual oscillator. (I am indebted to Prof. Van Vleck for this term.) The "virtual orbit" has the same frequency as the "virtual oscillator." However, its reaction to the external field is comparable with that of an electron the orbit of which is the mean of all the orbits between the two stationary states. (The meaning of "mean" is of necessity somewhat indefinite.) It is clear that in the general case a properly taken sum of the contributions of the various ν_i^a, ν_i^e will give the required result. Thus it is sufficient to attribute to a transition between a quantum state of quantum number $(n_1+\tau_1, \ldots n_u+\tau_u)$ to $(n_1, \ldots n_u)$ one half of the contribution to the polarisation on the classical theory due to the terms in frequencies $\tau_1 w_1+ \ldots +\tau_u w_u$ (in Bohr's notation) in order to satisfy the Principle of Correspondence.

It appears that the form of the theory here outlined is better capable of explaining dispersion at long wave-lengths (say for an atom in the normal state) than the form of Kramers because the characteristics of the motion are of greater influence on the "virtual orbit" than on the "virtual oscillator" point of view. By introducing a properly taken mean, one may hope to obtain the influence of a static field as a limiting case of a field considered in the theory of dispersion.

G. BREIT.
Physics Department,
The University of Minnesota,
Minneapolis, Minn.

THROUGH the courtesy of the Editor of NATURE I have been permitted to see Mr. Breit's letter, and I welcome the opportunity thus afforded me to add some further remarks on the theory of dispersion in order to elucidate some points which were only briefly touched upon in my former letter.

In addition to the empirical applicability of the dispersion formula of the type (4), the arguments which

[1] Prof. J. H. Van Vleck, of this University, has shown, in a publication which is to appear soon, that this formula satisfies the Correspondence Principle for the case of the general non-degenerate multiple periodic orbit.

e to the proposal of formula (5) rested on the
ssical expression for the amplitude of the secondary
velets which an incident plane wave sets up in a
stem of electrified particles. Consider a system,
e motion of which is of multiple periodic type, and
e the electrical moment M in a given direction of
e undisturbed system, which is supposed to possess
independent fundamental frequencies $\omega_1, \ldots \omega_u$,
represented by

$$M = \Sigma C \cos(2\pi\omega t + \gamma), \quad . \quad . \quad . \quad (1^*)$$

ere the frequencies $\omega = \tau_1\omega_1 + \ldots \tau_u\omega_u$ and the
plitudes C depend on the quantities $I_1, \ldots I_u$,
ich in the theory of stationary states are equal
integer multiples of Planck's constant h, as well
on the set of integer τ-values characteristic for the
sidered harmonical component of the motion.
It next the incident wave be linearly polarised with
electrical vector parallel to the given direction,
d let the value of this vector at the point where the
stem is situated be given by $E \cos 2\pi\nu t$. The
ctrical moment of the forced vibrations of frequency
et up in the system will then be equal to

$$P = \frac{E}{2}\Sigma\frac{\partial}{\partial I}\left(\frac{C^2\omega}{\omega^2 - \nu^2}\right)\cos 2\pi\nu t, \quad . \quad . \quad . \quad (2^*)$$

ere $\frac{\partial}{\partial I}$ stands as an abbreviation for $\tau_1\frac{\partial}{\partial I_1} + \ldots$
$\tau_u\frac{\partial}{\partial I_u}$.

Now in the limit of high quantum numbers the
equencies of the spectral lines connected with the
fferent possible transitions will coincide asymptotic-
ly with the frequencies of the harmonic components
the motion, and, according to the Correspondence
inciple, the energy of the spontaneous radiation
r unit time combined with each of these frequencies
ill be asymptotically represented by the expression
$\frac{(2\pi\omega)^4C^2}{3c^3}$. We will now make the assumption that,
this limit, formula (2*) gives an asymptotical
pression for the dispersion. In order to obtain
general expression holding for all quantum numbers
e note that, while the frequencies ω of the harmonic
mponents of the motion are given by the general
rmula

$$\omega = \frac{\partial H}{\partial I},$$

e exact expression for the frequencies of the
ectral lines is given by the general quantum relation

$$\nu_a = \frac{\Delta H}{h},$$

here ΔH signifies the difference of the energy H in
vo stationary states for which the values of $I_1, \ldots I_u$
iffer by $\tau_1 h, \ldots \tau_u h$ respectively. The assumption
resents itself that, in a generalisation of formula
2*), the symbol $\frac{\partial}{\partial I}$ has to be replaced by a similar
ifference symbol divided by h. This is just what
as been done in establishing formula (5). In fact,
is formula is obtained from (2*) by replacing the
ifferential coefficient multiplied by h, by the differ-
nce between the quantities $\frac{3c^3A^ah}{(2\pi)^4\nu^{a2}(\nu^{a2} - \nu^2)}$ and
$\frac{3c^3A^eh}{(2\pi)^4\nu^{e2}(\nu^{e2} - \nu^2)}$ referring to the two transitions coupled
espectively with the absorption and emission of the
pectral line which corresponds with the harmonic
omponent under consideration.

Apart from the problem of the validity of the underlying theoretical assumptions and of any eventual restriction in the physical applicability of formula (5), the dispersion formula thus obtained possesses the advantage over a formula such as is proposed by Mr. Breit in that it contains only such quantities as allow of a direct physical interpretation on the basis of the fundamental postulates of the quantum theory of spectra and atomic constitution, and exhibits no further reminiscence of the mathematical theory of multiple periodic systems.

In this connexion it may be emphasised that the notation "virtual oscillators" used in my former letter does not mean the introduction of any additional hypothetical mechanism, but is meant only as a terminology suitable to characterise certain main features of the connexion between the description of optical phenomena and the theoretical interpretation of spectra. This point is especially illustrated by the appearance of negative as well as positive oscillators, which helps to bring out the new feature, characteristic of the quantum theory of spectra, that the emission and absorption of a spectral line is coupled with two separated types of physical processes. The fundamental importance of this general feature for the interpretation of optical phenomena is, as mentioned in my former letter, indicated by the necessity, pointed out by Einstein, of introducing the idea of negative absorption in order to account for the law of temperature radiation.

H. A. KRAMERS.

Institute for Theoretical Physics,
Copenhagen, July 22.

Lake Victoria and the Flow of the Yala River.

DURING a recent investigation into the epidemiology of sleeping sickness along the east coast of Lake Victoria, north of the opening of the Kavirondo gulf, I observed the following phenomena which I trust some readers of NATURE may be able to explain, for I cannot.

The river Yala, which enters the lake at this part of the coast, passes through swamps which are kept back from the lake by sand-banks. Having landed here I noted many channels cut through the sand, running inland from the lake. The local natives said, "These were made by our forefathers, six generations ago, to drain the swamps." I pointed out that at that moment (about 9.30 A.M.) the water was not running out *from* the swamp but *into* it from the lake at quite a considerable rate, which I thought might be two miles per hour.

The natives replied that the current ran thus from daybreak until two in the afternoon, when it was reversed and flowed back into the lake. This is the daily routine so long as the lake is at the higher levels of its seasonal variations; when it is low, in the dry season, the flow through these channels is always from the swamp.

I am much puzzled as to the explanation of this diurnal variation, which cannot be accounted for by changes in direction of wind. I was working along that coast for several weeks and soon noted that the breeze from lake to shore (westerly, here) does not commence before 9.30 A.M., often not till ten; until that time, from the small hours, there is a strong cool breeze from off shore.

I omitted to ask the natives in which direction the current flowed during the night: they had said "from daybreak," but that probably means merely the earliest time when they noticed it.

Since it occurred to me that the great loss which must take place from the open lake by evaporation during the heat of the day might conceivably lower

the level of the lake in the afternoon, I obtained readings of the level at Entebbe by the official recorder at 8 A.M., noon, and 4 P.M. On three successive days the records were as follows :

Date.	8 A.M.	Noon.	4 P.M.
July 2 . . .	10·42	10·42	10·42
,, 3 . . .	10·42	10·42	10·42
,, 4 . . .	10·41	10·42	10·41
,, 5 . . .	10·40	..	..

This explanation, therefore, is not possible, and indeed seems improbable in consideration of the vast size of the lake and the relatively small amount of water poured into it by the Kagera and smaller rivers, of which the Yala is one. The inflow would need to be very much larger in order to raise the level of the whole lake during a single night.

G. D. HALE CARPENTER,
Uganda Medical Service.

Entebbe, Uganda, July 5.

English Enemies of the American Slipper-limpet, *Crepidula fornicata*.

IN 1923 the present writer found a shell of a dead slipper-limpet (*Crepidula fornicata*) at West Mersea, Essex, bored extensively by the boring sponge *Cliona celata*. This year a good number of living slipper-limpets have been examined, and one, the fourth individual of a chain of 8 living ones, was found with the living sponge boring into the shell. In the shell of the dead animal the sponge could be seen to have bored through all parts including the shelf, but had been inhibited from perforating over almost the whole of the area on the dorsal side, where another slipper-limpet had been attached to it. In the living specimen the sponge can be seen to be forming a honeycomb mesh-work in the dorsal portion of the shell, but it has only perforated to the surface in the postero-dorsal region ; the shelf of the shell is also attacked and is almost perforated in places. On the part of the shell where the next individual in the chain was sitting there is a nodular deposition of calcareous matter over strands of the sponge tissue. This deposit has been laid down, not by the owner of the shell, but by the individual sitting on the shell, and undoubtedly as a reaction to the irritation caused by the sponge. Crepidula has, therefore, found an enemy in Cliona in its new environment, and it will be interesting to know to what extent the slipper-limpet will be attacked in future in view of its economic importance.

Crepidula has other enemies. I have observed the whelk-tingle, *Ocinebra* (*Murex*) *erinacea*, attack the shell of Crepidula and bore through to the body, and shells can be found on the oyster-beds also bored either by Murex or Purpura, but it is difficult to estimate whether the boring whelks are of much value in killing off numbers of Crepidula. Whitstable fishermen know that dabs, *Pleuronectes limanda*, eat Crepidula, and I have seen fresh slipper-limpets in recently opened stomachs of this fish, but it seems likely that many of these limpets are obtained from chains broken in the dredging operations. Mr. Luckhurst, of Whitstable, informs me that starfishes, *Asterias rubens* chiefly, attack Crepidula, especially in winter time, when the slipper-limpets have apparently been weak. Since Crepidula was introduced into England from America round about the year 1880, it will be interesting to know from time to time in the future what English marine animals become inimical to it. At present Crepidula appears to be maintaining its dominance in the rich waters of the Thames Estuary ; this year there is a great fall of spat in many places in the north-western portion of the Estuary, although for the last few years the spatfall has been below the average in most places.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, July 29.

Former Fertility of the Kalahari Desert.

PROF. J. W. GREGORY, in his article on my recent Kalahari pamphlet in NATURE of April 12, p. 5[illegible] objected to my citing the Sylphium of Cyrenaica as evidence of the former fertility of the desert. I also gave the wine palm, *Raphia monbuttorum*, as evidence for, whereas it formerly lived in the Egyptian oases it is now confined to the more humid regions further south. Hassanein Bey has recently given evidence to the same effect in the oases of Kufra and Ouenat. In the latter place he describes rock drawings of ostriches, giraffes, and other animals that require grassland, and could not possibly live in the desert as it is to-day. The fact that there are no camels shown indicates that the pictures were made before A.D. 640, when the Arabs arrived in Africa with the camels. Nowadays, life in Ouenat would be impossible without these animals.

In South Africa we have the same evidence in Bushman drawings of hippopotamus, rhinoceros, and other animals, where these could not live to-day although we know they lived all about here 100–150 years ago. The last lion, hippopotamus, and rhinoceros were shot in the neighbourhood by the fathers of people still living in Grahamstown. I have already given the evidence of the Yellow-wood (Podocarpus), the typical Knysna forest tree, still lingering on hills in Namaqualand in what is now practically desert, and a few specimens are found on isolated hills between there and Cape Town. Recently, however, I have been shown by my neighbour, Mr. M. Godlonton, a specimen of the Winterberg bamboo (*Arundinaria tessellata*, Monroe), growing in his garden, which is a striking proof of more humid conditions not very long ago. It was only one hundred and fifty years ago since Barrow, Lichtenstein, and le Vaillant saw our Karroo plains swarming with big game, as now in Uganda, and we have every reason to believe that at that time the slopes of the mountains were covered with bamboo forest as now on the Nandi plateau in Central Africa, and of which these few stray stragglers still survive.

The Winterberg is about 7000 ft. and some miles north of Grahamstown. E. H. L. SCHWARZ.

Rhodes University College,
Grahamstown, July 16.

Chalky Boulder Marl at Hastings.

As relief workers in the Hastings district are continuously laying bare geological sections of first-class importance, and as the demands upon my time have precluded the possibility of my bringing the full details before scientific societies, I feel that geologists in general would be interested in a short account of them in the pages of NATURE. They relate not only to Wealden but also to Pliocene and Pleistocene times.

WEALDEN.—Excavations in the Wadhurst clay have brought to light a remarkable richness of both vegetable and animal life, particularly among the mollusca in which Nature has shown herself most energetic, not only in the cases of well-known genera and species of ordinary character—necessitating a revision of the Wealden mollusca—but in others she has shown great prodigality, some of the gastropods—dextral and sinistral—attaining a length, or height, of sixty feet

and upwards. These sections have also given the life-history of important rocks and rock-structures, and furnished serial examples of the metamorphoses by which the dense hard "blue-stone" is gradually altered into a soft, brilliantly coloured agatelike sandrock. (I have presented a somewhat extensive series of these to the British Museum (Natural History).)

PLIOCENE.—Beds of this age have been cut through, showing deposits of beautiful red-yellow loam, fifty feet thick, now lying at various altitudes, from a little above O.D. up to more than five hundred feet. These overlie a series correllatable with those of Ightdown. The underlying flint gravel is very much stained and of an orange-red colour, so familiar in East Anglia. The basement original sand is now indurated into a sandstone, requiring heavy steel tools to work it, in which were found worked flints. This, I think, is the first time worked flints have been found in a dense tertiary sandstone; naturally, the flints have undergone a great deal of alteration since they were chipped.

PLEISTOCENE.—The latest revelation has been made in the forming of battered-down lawn-tennis courts, upon the adjoining hillsides, and overlying the loam. The most southern court is cut out of chalky boulder marl, very white in colour. The associated boulders were often between two and three feet long, and consist of various gneisses, schists, granites, and numerous volcanic and metamorphic rocks; and sedimentary rocks foreign to the locality; and palæozoic and mesozoic fossils and rocks. The upper part of this big boulder drift was associated with immense worked flints, especially Wealden "flints," bulbed facets sometimes reaching one hundred square inches. The smaller implements are of well-known Mousterian types. In the overlying material came the orange-red-brown implements which I regard as of Aurignacian age. These later occur by thousands on certain hill-tops and valley shoulders in a quartzite drift full of glacially striated and faceted foreign rocks, originating in the destruction of just such glacial drift as is now revealed. Above these came quantities of the productions of the Hastings Kitchen Midden men. My esteemed colleague, Mr. Lamplugh, informs me that a similar drift has been reported to him from another locality. It now appears certain—if there be such a thing as a certainty—that glacial conditions reached even beyond our present shore line, and probably extended over the Great South river, as is shown by similar deposits near the French coast.

W. J. LEWIS ABBOTT.

Zoological Nomenclature: Thirty-five Generic Names of Mammals.

THE following generic names of mammals (with the genotype in parentheses) have been submitted to the International Commission on Zoological Nomenclature for inclusion in the Official List of Generic Names.

The Secretary will delay final announcement of the votes on these names until January 1, 1925, in order to give to any zoologists who may desire the opportunity to express their opinions.

Alces Gray, 1821, 307 (*alces*); *Arvicola* Lac., 1799, 1 (*amphibius*); *Ateles* Geoffr., 1806, 262 (*paniscus*); *Bison* H. Smith, 1827, 373 (*bison*); *Bradypus* Linn., 1758a, 34 (*tridactylus*); *Canis* Linn., 1758a, 38 (*familiaris*); *Capra* Linn., 1758a, 68 (*hircus*); *Cebus* Ixl., 1777, 44 (*capucina*); *Cervus* Linn., 1758a, 66 (*aphus*); *Cholœpus* Ill., 1811, 108 (*didactylus*); *Condylura* Ill., 1811, 125 (*cristatus*); *Cricetus* Leske, 1779, 168 (*cricetus*); *Crocidura* Wagl., 1832, 275 (*leucodon*); *Cystophora* Nills., 1820, 382 (*cristata*); *Dasyprocta* Ill., 1811, 93 (*aguti*); *Didelphis* Linn., 1758a, 54 (*marsupialis*); *Erethizon* F. Cuv., 1822, 432 (*dorsata*); *Felis* Linn., 1758a, 41 (*catus*); *Gulo* Pallas, 1780, 25 (*gulo*); *Halichœrus* Nills., 1820, 376 (*grypus*); *Lepus* Linn., 1758a, 57 (*timidus*); *Lynx* Kerr, 1792, 32 (*lynx*); *Mus* Linn., 1758a, 59 (*musculus*); *Myrmecophaga* Linn., 1758a, 35 (*tridactyla*); *Nasua* Storr, 1780, 35 (*nasua*); *Ovibos* Blainv., 1816, 76 (*moschatus*); *Phyllostomus* Lac., 1799, 16 (*hastatus*); *Procyon* Storr, 1780, 35 (*lotor*); *Putorius* Cuv., 1817, 147 (*putorius*); *Rangifer* H. Smith, 1827, 304 (*tarandus*); *Rhinolophus* Lac., 1799, 15 (*ferrum-equinum*); *Rupicapra* Blainv., 1816, 75 (*rupicapra*); *Sciurus* Linn., 1758a, 63 (*vulgaris*); *Sorex* Linn., 1758a, 53 (*araneus*); *Vespertilio* Linn., 1758a, 31 (*murinus*).

C. W. STILES.

U.S. Public Health Service,
Washington, D.C.

von Zeipel's Red Star near M 37.

THE very red star in the outlying regions of Messier 37 referred to in the Astronomical Column of NATURE of June 14, p. 870, was brought to our attention some years ago by Prof. v. Zeipel as an object of unusual interest.

Three polar comparison photographs in March and September 1921 gave a mean photovisual magnitude of 12·86, in exact agreement with v. Zeipel's result in *Astr. Nach.* 5288. Two polar comparisons made with ordinary plates on September 6 and 8, 1921, gave for the photographic brightness 17·75 and 17·95 respectively. The latter values are not very trustworthy, because the images were near the limiting magnitude of the plates; but the mean, 17·85, should be within 0·2 of the true photographic magnitude on the international scale.

The provisional colour index is, therefore, 5·0 mag. The ratio of the integrated intensity of the photovisual region of the star's spectrum (approximately λ5000 to λ6000) to that of the region to the violet of λ5200 is accordingly about 100 times the corresponding ratio for an Ao star.

FREDERICK H. SEARES.

Mount Wilson Observatory,
Pasadena, California, July 25.

A Biological Study of Radiation.

THE review of the second edition of our book, "Radium, X-rays, and the Living Cell," under the above title in NATURE of July 26 cannot pass without comment from us. One out of the two columns devoted to this review is a dissertation by the reviewer on the avoidance, by suitably directed regime and feeding, of the ills that fall to the lot of civilised man, including complaints such as cancer, dyspepsia, gastric and duodenal ulcer, gallstones, appendicitis, etc. We think that the natural inference of your readers will be that we have been writing on these matters; but we have neither written on this subject, nor do we subscribe to the opinions of the reviewer. Our efforts in producing the second edition of this book have, as in the first edition, been devoted to bringing together the chief experimental facts which have been ascertained of the effects which the rays from radium and X-rays have upon living organisms, and discussing very briefly any generalisations which may be possible on these facts.

HECTOR A. COLWELL.
SIDNEY RUSS.

Cancer Research Laboratories,
The Middlesex Hospital, W.1,
July 29.

Tropical Colonisation and the Future of Australia.[1]

By Prof. J. W. GREGORY, F.R.S.

IN North America the presence of the Negro has introduced problems of inscrutable perplexity; in South America a mixed race is in firm possession; in Africa as a whole the white man has no chance as a colonist; and in South Africa his future depends on some complex measure of segregation. In Asia, only in the north and north-west has the white man any prospect of permanent dominion. In contrast to these restrictions, in Australia the fundamental problem is the possibility of the occupation of the whole continent by the European race.

When the chief inrush of immigrants into Australia occurred after 1850, the belief was almost universal that the natural home of the white man was in the temperate zones and that the torrid zone must be left to the coloured races. That policy was accordingly adopted by Australia and pursued for fifty years. The tropical districts were left open, with varying limitations, to Asiatic immigration. Few Asiatics, however, took advantage of this opportunity, though large numbers were eager to enter the cities and settlements in the south, where the European had done the pioneer work. In the north the Asiatics were a hindrance, as they were too few to help materially, and they were sufficient to discourage the entrance of white artisans.

In 1901 Australia, on federation, found itself faced by two problems—the empty north which the open-to-Asia policy had not filled, and the disturbing effect of indentured coolies on white labour. The policy of excluding coloured people and working the northern plantations with white labour was declared to be a physical and physiological impossibility. In 1907, in opposition to this traditional view, I remarked ("Australasia," i. p. 15) that "medical authorities on tropical climates seem now, however, to be coming to the opinion that this view is a popular prejudice which does not rest on an adequate foundation." The evidence to that effect had been stated in a remarkable paper by Dr. L. W. Sambon, and endorsed by the late Sir Patrick Manson, and has been supported by the general trend of medical opinion during the past seventeen years.

The general distribution of mankind is in such close agreement with the rule that the white race has settled in the temperate regions and left the tropics to the coloured races, that any policy inconsistent with that arrangement must be prepared to encounter a strong prepossession to the contrary. Nevertheless, that rule is inconsistent with so many facts that it is not a safe basis for a national policy. In America, for example, the whole continent, except for the Eskimo in the north, was occupied by dark-coloured Mongolian tribes, in which, according to Flower and Lydekker ("Mammals," 1891, p. 752), "the colour of the skin, notwithstanding the enormous difference of the climate under which many members of the group exist, varies but little." The most northerly part of Europe is occupied by a coloured race, the Lapps. In Africa the darkness of the skin does not always vary in accordance with distance from the Equator.

[1] From the presidential address, "Inter-Racial Problems and White Colonisation in the Tropics," delivered to Section E (Geography) of the British Association at Toronto on August 7.

Supposed Unfavourable Factors in Tropical Climate.

(*a*) *Heat.*—The belief in the unsuitability of t tropics for the white man rests on several considerati Most importance is naturally attributed to the he as that is the essential difference between the tropi and other zones. Intense heat is regarded as injuri to people not protected by a dark skin. That vi overlooks the automatic process by which the livi body adjusts itself to temperatures even higher th occur in any climate on earth, and that would quic cook it, if dead. During some experiments by Charles Blagden in 1774, Sir Joseph Banks remain in a room for seven minutes at a temperature of 21 and Blagden subsequently stayed at the temperature 260°, while eggs were roasted hard and beefstea cooked in a few minutes. White men work in furna and bakeries at 600° F., and if they can survive su temperatures even for short spells, they should able to withstand the hottest climate on earth.

That heat is not the dangerous factor in the tropic obvious from the well-known fact that the hottest ar are often the healthiest. Agra is hotter and health than Bombay, and the summer heat of Colorado fiercer than that in the less healthy Mississippi Valle

(*b*) *Moist Heat.*—As dry heat affords no explanat of the high mortality of some tropical localities, app was made to moist heat, and to the combination of h and moisture marked by a high wet bulb temperatu At any temperature above blood heat the body cooled only by the evaporation of perspiration, wh does not take place in air saturated with moistu Hence in the Townsville experiments a man placed a room in which the wet bulb temperature rose fr 98° to 102°, fainted in forty minutes. In a hot local a dose of atropin, which suppresses perspiration, m be quickly fatal.

A wet bulb temperature higher than blood h would be fatal to men, white or black; but no eartl climate has such temperatures. It was at first s gested that the limit of human activity was the v bulb temperature of 73°, but there are well auther cated records of miners working for four-hour sp for months at the wet bulb temperature of 80° to in Hongkong, the Straits Settlements, Beaufort Borneo, and Ocean Island in the Pacific. At all th places people, both white and coloured, survive th conditions. Hence the limit has been gradually rai and it is recognised that men can withstand wet b temperatures of 85°, though the power of work un such conditions is necessarily greatly reduced. T highest wet bulb temperature mentioned in Dr. Grif Taylor's record at Port Darwin is 81°. The wet b data for North Australia are scanty; but there see no reason to expect that any considerable areas ha a more uncomfortable climate than Calcutta, to wh Dr. Taylor compares the worst localities of tropi Australia. Calcutta is one of the healthiest cities India, and has a large and vigorous European popu tion, many of whom spend there the whole year.

Moist heat is trying and must be considered in judg

cmates from the standard of comfort and personal eciency. The investigation of wet bulb temperatures, te significance of which was shown by Sir John Haldane, has been developed in reference to the textile ilustries by Dr. Leonard Hill and Dr. Boycott, to rning by Sir John Cadman, to the conditions of tpical Australia by the work of Prof. Osborne and is been illustrated by the ingenious climographs of I. G. Taylor; it has yielded results of high practical vlue. But the wet bulb isotherm does not delimit te areas where the white man may live and work, and des not really affect the question of white *versus* black conisation, as there does not seem to be any reason t believe that black men could withstand a higher vt bulb temperature than white men. In answer to a inquiry on this question, Sir John Haldane replied tat his impression on the contrary was that "white rn can usually stand more heat than black men," and h reported the information given him that in places lie the Red Sea the Clyde stokers stand the heat better tn the Lascars, "and, in fact, have constantly to cry the latter out and lay them on deck to cool."

(*c*) *Monotony in Temperature.*—Another temperature fctor that has been appealed to is that depressing eiability of temperature which occurs on some tropical csts. Excessive monotony in the weather is no dubt depressing, and temperature changes have a smulating beneficial effect. Extremes of cold and hat are still more inconvenient and trying, and a nderate equability is often advertised as an attractive fture in a climate. The equability of the oceanic cmate is recognised as most favourable for many condions of health. The areas over which extreme uiformity of temperature prevails throughout the year ar, however, so restricted that this factor does not aect the problem of tropical settlement as a whole. Vth the exception of low tropical islands, places with nnotonously equable climates are in positions whence ahange may be secured by a visit to some neighbouring hl country.

(*d*) *Actinic Rays.*—A fourth factor to which much iportance has been attached in connexion with the tpical climate is the effect of the chemical rays of the sn. Great importance was once attached to the pnicious influence of the ultra-violet chemical rays of te sun on persons not protected by a dark skin. Isidents in the tropics were therefore advised to line tir clothes with orange-coloured fabrics to shield tmselves from the chemically active rays. These vws reached their extreme in the writings of Surgeon-Mjor C. E. Woodruff in 1905, who held that the actinic rys of the sun are so inimical to the white man that ty inhibit his permanent settlement within 45° of the Euator. He therefore regarded the tip of Patagonia a the only area in the Southern Hemisphere fit for vite occupation. The temporary stagnancy of the ppulation of Australia after the droughts of 1900–1902 h regarded as evidence that the native-born white Astralian and delicate New Zealander were wasting aay through physical decay due to the enfeebling snshine, just as the health of American and European cldren was being ruined by the "daft" practice, as h called it, of flooding schoolrooms and nurseries with sreams of light. Woodruff's conclusions have naturally bn disregarded.

Any deleterious effects of the chemical rays of the sun may be avoided by the use of appropriate clothes, and physical considerations suggest that a black skin should afford less protection than a white skin. Any injury that may be wrought by powerful sunshine, according to Aron's work in the Philippines, is due to the heat rays at the red end of the spectrum and not to the chemical rays. The modern lauded system of heliotherapy is based on the belief that strong sunshine is a powerful curative agency.

(*e*) *Miscellaneous Factors.*—The four previously considered factors have the advantage that they can be readily understood and tested; but as they have failed to provide any basis for the unsuitability of the tropics for the white man, the appeal has been shifted to a complex of tropical influences, including a rise of body temperature, the lessened activity of lung and kidney, and nervous disturbances. Dirt and disease and carelessly prepared food are also mentioned, though they are due to human agencies. The physiological effects of the tropical climate in this indictment are contradicted by high authorities. The rise in body temperature is emphatically denied amongst others by Breinl and Young from observations in Queensland, and by Chamberlain on the basis of extensive observations on American soldiers in the Philippines. A slight rise may occur in passing from the temperate regions to the tropics, but it is soon recovered; and Shaklee reports from his experiments on monkeys at Manila that "the healthy white men may be readily acclimatised to the conditions named—that is, to the tropical climate at its worst." Shaklee adds that the most important factor in acclimatisation is diet.

The asserted ill-effects of the tropics on respiration appear to have no more solid basis. Prof. Osborne found at Melbourne that the rate of respiration was increased on the hottest days, and his observations agree with those of Chamberlain in Manila. So far from the tropical conditions being injurious to the kidneys, it is asserted, as by Dr. A. B. Balfour, that there is less trouble with that organ in tropical than in temperate climates. The apparently inconsistent observations on the action of the kidneys between various tropical localities and people may be explained by differences in diet.

The remaining charges against the tropical climate are insignificant, or not based on climatic elements, or are indefinite. Some of the alleged factors are trivial, such as the liability to various skin diseases owing to change in the skin reaction; for if the white man allows himself to be kept out of any country by such a cause he does not deserve to get in. The hygienic troubles due to association with an insanitary people are sometimes adduced; but they are not an element in climate and would not operate in a land reserved for white people. The remaining factors rest on ill-defined nervous ailments which are more likely to be due to domestic difficulties than to climate. These nervous troubles fall mainly on the women who have the strain of disciplining native servants into conformity with British ways. Nervous disorders are said to be worst in hot, dry, dusty regions which in the tropics are generally regarded as the most healthy, except to those whose constitutions require a moist atmosphere.

Medical opinion has gone far towards the general adoption of the conclusion that there is nothing in

climate to prohibit the white man from settling in the tropics.

As an example of a recent authoritative verdict may be quoted the report of a sub-committee appointed in 1914 by the Australian Medical Congress to investigate the medical aspects of tropical settlement. After extensive inquiries, the comparison of the blood of children born and bred in the tropics with those of the temperate regions, and other evidence, the sub-committee reported in 1920 as follows: "After mature consideration of these and other sources of information embodying the results of long and varied professional experience and observation in the Australian Tropics, the sub-committee is unable to find anything pointing to the existence of inherent or insuperable obstacles in the way of the permanent occupation of Tropical Australia by a healthy indigenous white race. They consider that the whole question of successful development and settlement of Tropical Australia by white races is fundamentally a question of applied public health in the modern sense. . . . They consider that the absence of semi-civilised coloured peoples in Northern Australia simplifies the problem very greatly."

Improvements by Public Sanitation.

The trend of medical opinion to the view that there is no physiological reason why the white race should not inhabit the tropics may lead to a change similar to that regarding some localities in the temperate zones, which were formerly regarded as death-traps and are now popular health resorts. The island of Walcheren, on the coast of one of the most densely peopled countries in Europe and only thirty miles from so fashionable a watering-place as Ostend, had, a century and a quarter ago, one of the most deadly climates in Europe. The largest army which had ever left the British islands landed there in 1809. Napoleon did not think it worth powder and shot. "Only keep them in check," was his order, "and the bad air and fevers peculiar to the country will soon destroy the army." Napoleon's judgment was justified. The force of 70,000 men disembarked on July 31 and August 1. By October 10, according to Sir Ranald Martin, 142 per thousand were dead of disease, and 587 per thousand were ill.

Algeria is now a trusted sanatorium. Yet disease annually swept away 7 per cent. of the French army that conquered it. Sir A. M. Tulloch remarked that if the French Government had realised the significance of that mortality "it would never have entered on the wild speculation of cultivating the soil of Africa by Europeans, nor have wasted a hundred millions sterling with no other result than the loss of 100,000 men, who have fallen victims to the climate of that country." The same change of view has taken place in reference to some tropical localities. The deadliness of the Spanish Main to our armies was described by Samuel Johnson. "The attack on Cartagena," he said, "is yet remembered, where the Spaniards from the ramparts saw their invaders destroyed by the hostility of the elements; poisoned by the air, and crippled by the dews; where every hour swept away battalions; and in the three days that passed between the descent and re-embarkation half an army perished. In the last war the Havanna was taken, at what expense is too well remembered. May my country be never cursed with such another conquest." Yet Havana, under American administration, has become one of the healthiest cities in the world.

Sir John Moore, when Governor of St. Lucia (179 wrote home that it is not the climate that kills, b mismanagement. His insight has been demonstrat in the same region. The French attempt to build t Panama Canal was defeated by disease. Discovery its nature enabled the late Surgeon-General Gorgas secure for the 10,000 men, women, and children in t canal construction camps, in spite of the high hum heat, as good health as they would have had in t United States. Gorgas claimed that the results Panama "will be generally received as a demonstrati that the white man can live and thrive in the tropic Gorgas realised that the results for the future are ev more momentous. He predicted that as "the amou of wealth which can be produced in the tropics fo given amount of labour is so much larger than th which can be produced in the temperate zone by same amount of labour, that the attraction for white man to emigrate to the tropics will be very gr when it is appreciated that he can be made safe as his health conditions at small expense. When great valleys of the Amazon and of the Congo occupied by a white population, more food will produced in these regions than is now produced in the rest of the inhabited world."

The Development of Tropical Australia.

The experience of colonisation in tropical Austra is limited to about seventy years; but it affords ground for the expectation that the ultimate effects the white race will be detrimental.

(*a*) *Vital Statistics in Queensland.*—In Queensla most of which is tropical, the death-rate is lower th in any European country and is lower than in mos extra-tropical Australia. In the six years 1915- according to the statistics in the Australian Year-b (No. 15, 1922, p. 99), the crude death-rate in Queensl was the lowest in the six Australian States for one y and fourth of the six States in three years, and the f in three; it was not once the highest. In the same years the infantile death-rate was lowest in Queensl in three years, and the second lowest in two oth According to the same authority, by Index of Morta (*i.e.* the death-rate in proportion to the ages of community), Queensland was in 1921 the second St in order of merit, being inferior only by 0·03 to N South Wales, the State most favoured in this respe

The physical vigour of the Queenslander is shown his athletic prowess, and by the low rejection-rate recruits from that State for the Citizen Army. longevity in Queensland may be judged by the exp ence of the life assurance offices. It has often b asserted that assurance rates show that tropical clima are unhealthy. Yet the chief actuary for the grea Australian assurance company, the Australian Mut Provident Society, reported to the Committee of Australian Medical Congress, "I have no hesitation saying that as far as we know at present there is need for life assurance offices to treat proponents w live in North Queensland differently from propone who live in other parts of Australia."

Physical and mental degeneration in a people liv

der unfavourable conditions would probably be most readily observed in the children. To use this clue I asked the Queensland Education Department whether its inspectors had noticed any unfavourable symptoms among the children in the most tropical of its northern schools. The Department replied that on the contrary its schools at Cairns and Cooktown, two of the most northern towns, are exceptionally efficient, and one of them is sometimes the leading school in the State.

(*b*) *Northern Territory.*—The great success of Queensland, although more than half the State is within the tropics, renders the more striking the failure of the adjacent Northern Territory of Australia, of which the records are disappointing. Agriculture has declined; the Government demonstration farms have been reduced to native reserves; the meat works have been closed; the population has fallen in numbers; and mining production has become insignificant. The present state of the Territory has been adduced as evidence of the futility of trying to develop a tropical land by white labour. Its failure was not, however, due to the White Australia policy, which was introduced after the failure was complete, but to geographical disadvantages not yet surmounted. The Territory, before 1901, was open to Asiatic immigration, but the hope that it would be adequately peopled from Asia was not fulfilled. Poorness of soil, unsuitable distribution of rainfall, and inaccessibility of position explain its backwardness. Great hopes are based on cotton, but its profitable cultivation appears dependent upon the establishment of a protected cotton manufacture in Australia, which would secure a market for the crop at a price that would pay for the high cost of picking. The remedy for the failure lies not in another attempt with Asiatics, but in the removal of the isolation of the Territory.

(*c*) *Queensland and the Sugar Industry.*—Queensland in contrast to the Northern Territory has made firm progress; the population has continued to increase; although at first coloured labour was introduced, the proportion of the Asiatic population in 1911 was only 1·7 per cent., and of the Polynesian only 0·29 per cent. The numbers of coloured labourers in Queensland were too small seriously to affect the population, but they were sufficient to be a constant irritant and source of uncertainty in the local labour market. This trouble led, in 1900, to the prohibition of indentured coolie labour throughout Australia. This decision was supported by the great majority of the Queensland people despite of the most emphatic warnings of disaster.

The Australian adoption of white labour for its sugar plantations has been the greatest contribution yet made to the practical solution of the problem whether the white man can do agricultural work in the tropics. The experiment shows that white labour can be employed successfully in such an ultra-tropical industry as sugar cultivation in even the ultra-tropical climate of the Queensland coastlands, provided the settlers are protected from infectious disease and from the competition of people with lower standards of life.

Drawbacks of the Tropical Climate.

The conclusion that white settlement of the tropics is possible should not lead to the drawbacks of a tropical climate being overlooked. The conditions where the wet bulb temperatures are high are uncomfortable and unfavourable to mental and physical activity. People who are not keenly interested in their work should avoid the tropics. Ellsworth Huntington in a valuable series of works has directed attention to many facts which show the dependence of Western civilisation on the stimulating nature of the temperate climate, for the frequent changes in temperature and wind are conducive to alertness and general efficiency.

The enervating effect of the tropical climate is no doubt counterbalanced by various compensations. Man needs less in food, fuel, clothing, and housing, while the same amount of exertion will produce a more luxuriant and valuable crop. The supremely fertile tropical regions have, however, usually a hot muggy climate, which is not attractive to Europeans while areas with less trying conditions are available. Northern Australia, even if it were not hampered by a high proportion of poor land, would naturally develop slowly, just as in Canada the Northern Territory and the rocky backwoods have lagged behind the St. Lawrence basin and the rich-soiled western plains.

Conclusion.

The conclusion that the white man is not physiologically disqualified from manual labour in the tropics and may colonise any part of Australia simplifies interracial problems, as it provides an additional outlet and spacious home for the European race.

The preceding survey of the position where the three main races meet in intimate association indicates that the world will have a happier and brighter future if it can avoid the co-residence in mass of members of the different primary divisions of mankind. Individual association and contact should secure for each race the benefit of the intellectual, artistic, and moral talents of the others; while industrial co-operation should aid each nation to make the best use of the land in its care.

The world has reached its present position by the help of each of its three great races, and it still needs the special qualities of each of them. The contemplative Asiatic founded all the chief religions, the ethical basis of civilisation. The artistic Negro probably gave the world the gift of iron, the material basis of civilisation. The administrative genius of the European race has organised the brain power of the world to its most original and constructive efforts. The affectionate, emotional Negro, the docile, diligent Asiatic, and the inventive, enterprising European do not, however, work at their best when associated in mass. That association is attended with serious difficulties; for race amalgamation, which is the natural sequel, is abhorrent to many nations, and the intermarriage of widely different breeds, according to many authorities, produces inferior offspring. The policy of co-residence with racial integrity has failed to secure harmonious progress in North America and South Africa. The development of the best qualities of the three races requires their separate existence as a whole, with opportunities for individual association and co-operation.

In view of the inter-racial difficulties that have developed wherever the races are intermingled, Australia will throw away a unique opportunity if it fails to make a patient effort to secure the whole continent as the home of the white race.

A Philosopher on Relativity.

By Sir OLIVER LODGE, F.R.S.

AT the twenty-third annual meeting of the Eastern Division of the American Philosophical Association, held at Brown University, Providence, R.I., in December 1923, a presidential address on "The Einstein Theory and a Possible Alternative" was delivered by Prof. William Pepperell Montague, professor of philosophy in the Columbia University of New York. In this address Prof. Montague shows himself to be a philosopher rather especially interested in physics; and he claims the advantage of having discussed certain aspects of the subject with Prof. Bergen Davis and other members of the physics department at Columbia. He reviews and criticises parts of the Einstein theory in a lively manner, thereby arousing interest among philosophers; and his contentions are deserving of notice.

Apparently Prof. Montague raises no objection to Einstein's General Theory, so far as it deals with matter and gravitation, and so far as it replaces the idea of force by the idea of space-curvature. He seems to consider these apparently diverse ideas as only different methods of expressing the same thing; much as you might say that it does not matter whether you represent an ellipse by drawing it, or by writing $x^2/a^2+y^2/b^2=1$. Both modes of expression represent the same thing. Some might hold that a picture is a nearer approach to reality than a formula, but both call up relevant ideas in the mind. Moreover, a picture,—which regarded from a strict point of view is millions of molecules of one substance superposed upon billions of another,—must depend helplessly on the human mind for recognising in it any of the properties of an ellipse!—must, in fact, depend just as much on mind for its interpretation as does the algebraic convention. After all, as regards precision of measurement, the mathematical rather than the pictorial presentation is the more explicit and accurate of the two.

I must make it clear that Prof. Montague expresses appreciation of pure mathematics and feels no philosophical objection to those more striking and revolutionary ideas of Einstein which were borrowed from the pure mathematicians. In the geometrical way of regarding matter and force, the infinite finiteness of the universe, the representation of impenetrable specks of matter as impassable distortions of space,—in all this Prof. Montague rather rejoices; as the following extracts will show:

". . . bodies moving with accelerated velocities are subject to forces, hence the later Einstein theory consists, first, of a new though Cliffordian conception of the nature of *force*; and, second (growing out of that), of a new though Riemannian conception of the *universe itself*, as a domain at once boundless and finite. . . .

"Some will undoubtedly feel stifled and penned in at the thought that if they were to travel in a 'straight' line for only a few septillions of miles they would find themselves on the way home without ever having turned around. Others will find the new Riemannian hyper-sphere large enough for all practical purposes; and they will delight in the possibility of relating in some curious way the curvature or size of the universe as a whole to the dimensions of its minimum elements."

Prof. Montague does not think that the hyp geometrical conceptions of reality need be upset what he urges as failure in the simpler basis on wh the original doctrines of relativity were founded doctrines admittedly not so well established by act *ad hoc* observation of predicted results as those of t more general theory have been.

"It is not, I think, too inaccurate to say that wh the Special Theory reduces geometry to physics a is offensively destructive and phenomenalistic in conception of the world, the General Theory redu physics to geometry and its tone and temper rationalistic and constructive. The muddy prose Hume and Mach gives place to the clear poetry Riemann and Clifford."

Prof. Montague goes on to pay a tribute to the l Prof. Clifford, with which, as an old student and jun friend of that remarkable genius, I cannot but sy pathise:

"It was Clifford, working under the inspiration the new geometry of Riemann, who, I think, fi suggested that matter could be conceived as a n Euclidian wrinkle in space. . . . It is pleasant think that Clifford, whose mind was of such r beauty and who in his appreciation of spiritual val possessed what the musicians call a sense for absol pitch, should have been the first to hold a concept which now seems destined to have most far-reach consequences."

So it turns out that Prof. Montague's criticisms directed, not at the more recondite parts of the subj so finely developed and expounded by Eddington, l at its foundations as ordinarily expressed. His m objection seems to be to the Larmor-Lorentzian l for the composition of velocities, and to the absol constancy of the velocity of light as supposed to measured by different observers. He objects also this velocity being regarded as a maximum veloc which cannot be exceeded. His view is that ligh not really emitted and abandoned to a station ether, as a water splash is abandoned by a ship, l that light is continually associated with the lines field of force belonging to and moving with the sou —somewhat after Faraday's idea of ray vibratio an idea which, in modified form, has obtained weig support of late, and about which it is best not to dogmatic.

There has been a conspicuous tendency, of late, revolt against the simplicity of the undulatory the Something more than that is evidently wanted. A incidentally I may mention that Prof. Benedicks, the Metallographic Institute of Stockholm, has writ an immediately forthcoming small book called "Sp and Time," in which he supports some modificat of the emission theory. With a corpuscular the in empty space, the Michelson-Morley experim would raise no difficulty at all, and probably wo never have been performed; for the velocity of li would depend on the motion of the source, and eve thing would be simple. A similar simplicity is ain at by Prof. Montague. He does not indeed propos corpuscular theory—he sees difficulties in that,—l

is well aware that what he does suggest is quite ien, and indeed contrary, to the early parts of the instein theory. He adduces therefore simple imagin- y experiments, akin to those so often appealed to philosophic relativists, by which he thinks the instein view might be disproved. He realises the fficulty of doing anything effective with only two gnalling observers, who must be dependent on in- nclusive to-and-fro journeys, so he arranges a iangular duel, with a third observer, or rather gnaller, equidistant from the other two.

Let there be two observers on the same parallel of titude, with perfect signalling appliances and stop- atches, which, however they are affected by the tation of the earth, must at least go at the same rate ; nd let there be a third signaller at the north pole, ho by symmetry is able to establish simultaneity etween the other two. At the word "Go!" from he pole, the two on the equator signal to each other, nd time the interval between sending and receiving. rof. Montague claims that, on the ordinary wave heory, and as he mistakenly seems to think on the instein theory, the one travelling to meet the signal hould get it sooner than the one whom it has to vertake. For, as he says, even waves take less time travel less distance,—. . . "even Einsteinian light avels a shorter distance in less time than it does a nger distance."

On the other hand, on a corpuscular theory there ould be no observable difference, because the increased eed of the corpuscles from an ordinary source would mpensate for the recession of their recipient. So oth Prof. Montague and Prof. Eddington would, I resume, expect a negative result ; and the experiment ould not discriminate between them. Unless, indeed, gave a positive result, to the chagrin of both, and the iumph of a common-sense view based on the behaviour f ordinary waves.[1]

It will be observed, however, that Prof. Montague has bandoned translation, as hopeless for his purpose, and as utilised rotation ; and about rotation there has lways been something with a tinge of the absolute bout it, even in relativity doctrine. But whether it is ecessary to make this admission, in order to safeguard positive result from Prof. Montague's imaginary xperiment, is very doubtful. His own attitude is ostile to waves in a stationary ether, as well as to the ss intelligible doctrine that every observer, at all imes, must measure the same velocity for light; he oes not actually sustain or mention a corpuscular heory, as Prof. Benedicks does,—and as apparently the Swiss genius Ritz did,—but his postulated entanglement f the waves with the field of the source comes to omewhat the same thing.

Prof. Montague goes on to attack the composition of elocities in a more direct manner, and likewise ridicules everal curiosities of time measurement, including ueer tales by rapid travellers with return tickets, ited from Eddington and Weyl ; but concerning the ypothetical slowing down of physiological processes y motion, and other humorous interpretations of ertain equations, I am not myself seriously sym- pathetic enough to justify my trying to sustain them against criticism.

Incidentally I note that he has a long footnote in which, by means of to-and-fro north and south signalling compared with the result of similar east and west signalling, he claims that we might distinguish between Einstein and Lorentz,—whatever that may mean. It looks as if he thought that Einstein discarded the β factor representing the FitzGerald-Lorentz Contraction (introduced by Larmor in 1900, "Æther and Matter," p. 173 *et seq.*, and vigorously used by Einstein), while Lorentz admitted it. Either I misunderstand him here, or he makes a mistake.

The alternative which Prof. Montague seriously proposes to the relativity treatment of light is not the corpuscular theory,—for, as he says, "light is in almost all respects wave-like rather than corpuscular"—but it is this,

". . . that the medium or carrier of light waves is not a doubtfully existent ether-substance, but the certainly existent field of force which each electron and proton carries with it."

He thus desires to abolish a stationary ether, as Einstein does not, and claims that because an electric field is centred on its charged particle, it follows that when a charged particle moves, its field must move with it.

"The velocity *in* the field will be constant and absolute, but the velocity *of* the field has to be added to it."

Thus he tries to combine the advantages of the wave and emission theories in this respect. But the full treatment is not so simple ; a great deal is known about the way in which a field moves, and he would find himself immersed in plenty of complexities, unless he discarded electromagnetic theory altogether.

Finally Prof. Montague proposes an experiment to test his crucial assumption, namely, that the velocity of light is affected by the motion of the source, and is not independent of it as it would be in a stationary ether and as it is in Einstein's theory. His proposed experiment depends on rotation, again ; and, to summarise it briefly, it employs the idea that light from the sun's advancing limb ought to come to us quicker than from the receding limb. His proposed rotator is not the sun, however, but a mechanical cylinder, sphere, or disk, projecting light from opposite points of its circumference, through a couple of narrow slits or tunnels, on to a moving sheet of sensitive paper. The slits or narrow tunnels are carried by a pair of drums, which are separated by a considerable distance and are revolving about an axis at right angles to the main axis and parallel to the path of the two beams of light. (He makes these drums revolve in opposite senses, but that is surely a mistake or a needless complication.) It follows that if they are revolving quickly enough, the light may be unable to get through both slits, because of the time taken in the journey between them, and he claims that with increasing speed the fading of the spot from one beam should precede the fading of the other. His experiment therefore is really a Fizeau-like experiment to measure the velocity of light, or rather to compare the velocities from two oppositely moving sources without the use of a mirror or any return journey: the fading and disappearance of the traces on the photographic film at a certain

[1] May I direct attention to a clear pre-relativity description of all this lass of problem, in an old volume of NATURE for 1892 (vol. 46, pp. 497-502, nd also on pp. 164 and 165 ; the latter with a misprint of θ for ϵ in two laces).

speed of rotation being looked for, and the times of fading compared. But presumably any mode of determining the velocity of light would serve: the essence of the experiment is not the mechanical details, which are crude, but the suggestion that it is possible to find a difference in the velocity of light according as it comes from the approaching part of a rotating wheel or from the receding part.

Well, that is a definite suggestion for experiment, if any one really thinks it likely (as I do not) that the velocity of light depends on the motion of the source: though it would seem as if measuring the velocity of light from an approaching and receding star would be more likely to decide the question. At any rate, the difficulties encountered by employing a non-terrestrial source would be of another order. Prof. Montague fears, however, that a final entanglement of the light in the fields of atmospheric matter might interfere with a correct determination of velocity from an astronomical source. It might also be argued that the known Doppler effect, depending on stellar advance and recession, gives a relative frequency accurately calculable on the basis of a constant velocity for light, and that to supplement this by the peculiarities of a projectile kind of light would be merely perturbing. To this he would doubtless reply that a fair and square initial consideration of light as projected from its source will give the Doppler effect and explain the M.M. result with perfect ease. He might also claim, perhaps, that his variety of ray-wave would evade the usual Foucault objection to emission theories, and might give the Fizeau result in dense substances as well. These things are not elaborated in his paper.

But now—seeking what can be politely said in support of any of his contentions—it must be admitted, I think, that the relativity explanation of the Doppler effect can be made to look as if it had a weak point. Algebraically it comes out right, of course, but it has too much the air of the ordinary explanation, which attributes an obvious meaning to $c \pm v$. The ordinary explanation, for an observer approaching a source, is simply that the observed frequency increases in the ratio

$$\frac{n}{n_0} = \frac{c+v}{c}$$

by simple composition of velocities: which is still Professor Montague's, and used to be everybody's, argument. But, with the relativity law for compounding velocities, deduced from Larmor's transformation, this so described ratio would be unity, and there would be no Doppler effect at all if it had to depend on an apparently changed speed of arrival of the waves. Relativity, however, does not attempt to proceed by compounding velocities for the purpose of explaining the Doppler effect: it knows that c cannot be added to or subtracted from, by anything a source or an observer can do; so it simply applies the Larmor-Lorentz transformation to the space and time periodicities of wave motion, and deduces algebraically

$$\frac{n}{n_0} = \sqrt{\left(\frac{c+v}{c-v}\right)}.$$

Neglecting v^2/c^2 this has the same value as the ordinary expression above, and no experiment yet made can discriminate between them. But am I wrong in imagining that a relativist would dislike writing it in that form and would prefer the expression

$$\sqrt{\left(\frac{1+v/c}{1-v/c}\right)}?$$

For this, though identical, conveys no inappropriate suggestion of compounded velocities.

In conclusion, it is always satisfactory when controversialists can get up against a question of fact. Stripping it to bare bones, we may put these two questions:

(1) Does the velocity of light really depend on the speed of its source?

Wave theory, Einstein theory, ether theory, all say "no." Corpuscular theory answers "yes": and Prof. Montague's adopted conception of a ray vibration also, in his opinion (but as I think doubtfully) answers "yes."

(2) Does the measured or apparent velocity of light depend on the motion of an observer?

Corpuscular theory, and Prof. Montague's theory reply, "Yes if the source is stationary," "No if the source is moving with the observer." Ordinary wave theory would say "Yes in any case," for what the source is doing does not matter; that can only affect wave-length, not speed. Einstein's theory would loudly say "No in any case": for if one could discriminate between motion of observer and motion of source, relativity as commonly stated would be upset and attention to a stationary ether would be made inevitable. Experiment so far has declined to answer; for a to-and-fro journey involves squares and can be dodged. So then at present we have no discriminating reply, unless an answer in favour of Einstein is to be taken as implied by the general consistency and sufficiency of his theoretical results both old and new.

One who is impressed with the mysterious way in which the Larmor-Lorentz transformation thoroughly formulates all known results without any trouble or hesitation, and yet who is not helped thereby to form a clear physical conception of the process, might urge that to clinch matters an experiment is desirable which should aim at determining $c \pm v$; when v is the speed not of source, but of observer. That is, an experiment is wanted which would measure the speed of an observer relatively to light, and therefore relatively to a stationary luminiferous medium. Direct determination of the velocity of light at different seasons of the year, by any method, would at first sight seem able to settle this question, provided an accuracy greater than one in ten thousand could be attained.

But consider this further. A fixed space-interval and a time-keeper constitute the real observer: the FitzGerald contraction does not depend on whether motion is positive or negative, nor does direction of motion affect the rate of a clock. Hence if the experiment is made now and six months hence, x/t will equal x'/t', and no difference in the speed c will be perceived. That seems right from one point of view; and yet physically, waves *ought* to travel down an ether stream quicker than up, unless group velocity has something objectionable to say.

To sum up the position, still in an interrogative

[2] Because $\frac{x'}{t'} = \frac{x/t - u}{1 - ux/c^2t}$, which equals c if $x/t = c$, and not otherwise.

nner without dogmatism :—change of frequency epends solely on relative motion of source and server: combined motion of both through a medium es not affect frequency on any theory, so long as e motion is steady. Ordinary aberration is wholly d solely caused by motion of observer relative to th of ray. Is observed velocity of light depend- t on motion of observer, too? The strength of the ativity position is that no way of performing the experiment is likely to give a positive result, unless truly relative motion is introduced, as by mounting the whole receiver on the end of a revolving arm; and questionably even then. The strength of the ether position is that a relative ether stream past fixed "stations," though undemonstrated, is at least not negatived by this or any other experiment, and may therefore nevertheless be a reality. A philosopher may be able to explain what "reality" means.

Obituary.

DR. ROBERT KIDSTON, F.R.S.

BY the unexpected death of Robert Kidston on July 13, palæobotany suffers an irreparable loss. Dr. idston was still at the height of his activity, and had obably never been busier in his life than when the d came. He was then in South Wales, engaged on s fossil investigations. Equally distinguished in stematic and structural palæobotany, Kidston was e veteran leader in his science, worthy to rank with e great continental masters, such as Zeiller, Grand'- ury, and Nathorst, who had already passed away.

Robert Kidston was born at Bishopston House, enfrewshire, on June 29, 1852. The family removed ortly afterwards to Stirling, where Kidston's life as spent. As a young man Kidston went into siness in a bank, but his strong bent for natural story soon turned him towards scientific pursuits. bout 1878 he attended botanical classes in the niversity of Edinburgh. He was then, and remained roughout life, a keen field botanist.

Kidston soon became interested in fossil plants, and is work met with early recognition, for, from 1880 nwards, the plant-remains collected by the Geological urvey of Scotland were referred to him. This gave im his first great opportunity.

In Kidston's work as a fossil-botanist two periods ay be distinguished. From the beginning up to 904 he was predominantly a floristic and strati- raphical palæobotanist, and so indeed he continued o be, but from 1904 onwards he further took a leading art in morphological and structural investigation, and xpressed himself with a wise authority on the great uestions of affinity and descent. His work in every eld was remarkable for that sound judgment which as so generally characterised the best systematists.

From about 1880 a constant succession of papers n fossil plants was maintained; only a very few can e mentioned here. In 1886 Kidston was entrusted ith the duty of preparing a catalogue of the Palæozoic lants preserved in the British Museum, a valuable ork of reference in its time. Thus he was already ecognised as our leading systematist in Palæozoic otany.

Kidston always took a special interest in the ructification of ferns and fern-like plants. A paper ublished in 1887, "On the Fructification of some erns from the Carboniferous Formation," proved to e of exceptional importance, for various reproductive rgans described belonged, as Kidston afterwards howed, to the group of the Pteridosperms. Thus, in he case of *Neuropteris heterophylla*, of which he after- vards discovered the seed, the fructification described n 1887 turned out to be the male form.

The memoir on Lepidophloios (1892) is the leading monograph on that genus of fossil Lycopods. A paper on the various divisions of the Carboniferous rocks as determined by their fossil flora (1893) is a valuable contribution to the geology of that period. Two important memoirs on the fossil flora of the Yorkshire coal-field, on which he had already published a number of reports, appeared in 1896 and 1897. The second is of remarkable interest, as containing the first complete description of the cones of Sigillaria, and thus finally establishing the true nature of that long-disputed genus.

A general summary of the flora of the Carboniferous Period appeared in 1901–1902. This was written at a transitional time, when botanists had recognised the Cycadofilices as a class, but were still ignorant of their reproduction. Kidston's remarks do justice to the position at that date.

The second and more brilliant period of Kidston's work opens with his important paper on the fructification of *Neuropteris heterophylla* (1904). He was the first to demonstrate, by direct proof of continuity, that a fern-like plant of the Coal Age bore seeds. Previous evidence (only slightly antedating Kidston's discovery), however convincing, had been indirect. Kidston, in fact, was a pioneer in this field. A year later (1905) he published a preliminary note on Microsporangia in connexion with the foliage of Lyginodendron and was thus the first to identify the male organs of a "seed-fern." This was followed up in 1905 by his great memoir on the microsporangia of the Pteridospermeæ, a truly admirable work, showing a rare soundness of judgment in discussing the affinities of the newly discovered group.

A purely anatomical memoir on the internal structure of *Sigillaria elegans* (1908) was the first full and illustrated account of the structure of a ribbed Sigillaria. The work was extended to other species a year later.

Other papers on structural subjects dealt with new species of Dineuron and Botryopteris (early ferns) and with a new Lepidodendron from Pettycur, all of Lower Carboniferous age. Kidston had a special predilection for Lower Carboniferous plants, and was among the first to grasp the full importance of this fine flora.

One of Kidston's later memoirs on the fossil flora of the Staffordshire Coal-Fields (1914) includes a number of important discoveries, the most striking being perhaps the pollen-bearing organ of a new Neuropteris, very different from that of *N. heterophylla*.

The mere glance we have taken at a few outstanding papers may serve to show how Kidston's work illuminated every side of Palæozoic botany. His work was fully appreciated on the Continent and was by no

means confined to his own country. In 1911 appeared a fine volume on "Les Végétaux houillers recueillis dans le Hainaut Belge" containing various new genera and species. Another foreign work was his joint book with Dr. Jongmans on the Calamites of Western Europe, published by the Dutch Government. This is a huge monograph; the Atlas published in 1915 contains 158 fine plates. So far as the writer is aware, only a portion of the text has appeared.

It remains to notice briefly some of Kidston's work in conjunction with other botanists. One of his most valued colleagues was the late Prof. D. T. Gwynne-Vaughan, whose early death was so severe a loss to botany. Their work on the fossil Osmundaceæ, in five parts, ranging from 1907 to 1914, is a palæobotanical classic, tracing back the history of the Royal ferns from the Tertiary to the Permian. An admirable photograph is extant, showing the two collaborators at work together on this investigation. Other papers with Gwynne-Vaughan were on a Tempskya from Russia, by far the best account up to that time of this peculiar type of fern-stem, and on a Lower Carboniferous fossil, *Stenomyelon tuedianum*, discovered by Kidston. This is a model of anatomical work, concise, clear, and exhaustive.

Kidston's work in conjunction with Prof. W. H. Lang, on the Old Red Sandstone plants of the Rhynie Chert-bed (five memoirs, 1917–1921), was the most important of all, for it demonstrated, in full detail, the structure of the oldest land-plants of which we have any certain knowledge. Never was a great discovery more completely and wisely expounded. The simple plants of Rhynie, thanks to Kidston and Lang's researches, now form the basis of evolutionary work on the plant kingdom.

Other joint memoirs by the same authors were on Hicklingia, a new genus of Early Devonian Plants (1923), and on *Palæopitys Milleri* (1923), the famous but long neglected "cone-bearing tree" of Hugh Miller. The authors worked out the structure fully, but reserved judgment on the affinities of the plant, which is certainly of astonishingly high organisation for an Early Devonian horizon.

Kidston, at the time of his death, was engaged on what, from a floristic point of view, was to have been the greatest work of his career. This was nothing less than the full description and illustration of all the Carboniferous plants of Great Britain. The series, published by the Geological Survey, was planned to consist of ten memoirs but would, no doubt, have run to more. Four memoirs have been actually published, illustrated by 91 fine plates. They only embrace a portion of the ferns and fern-like plants. The systematic descriptions are illuminated by admirable observations on broader questions of affinity. It is understood that two more parts are sufficiently advanced for publication, and it is earnestly to be hoped that this magnificent work, a credit alike to the author and to the Department which undertook it, may eventually be brought to completion.

Kidston, among his other accomplishments, was a highly skilled photographer and was thus enabled to illustrate his own works, both systematic and anatomical, in a manner which adds immensely to their value and beauty. In all his writings Kidston showed himself a most fair and generous critic. His splendid colle tions both of impressions and sections were alwa available for the use of his scientific colleagues. T present writer, in particular, can testify how mu he owes to the constant and generous help of his o friend. D. H. S.

Prof. Alois Mrázek.

On November 26, 1923, died Dr. Mrázek, profess of zoology in the Charles' (Bohemian) University Prague. He was born in 1868 in Příbram, and origi ally worked under A. Frič in the patriotic study of t fauna, the aim of which was to increase the knowled of Bohemian fauna and the extension of the sing genera. Later on, under the influence of his secon teacher, Prof. Vejdovský, he devoted his study typical problems of the period of classical morpholo and cytology. He did not limit himself only to t discovery and description of new genera, but he w also interested in the problems, which are typical f the area, of the classical morphology and cytology.

Mrázek directed his study chiefly to the Crustac and Copepoda, especially to the hermaphroditism the first and the numerous anatomical details of t antennæ of the second, and the exactness of his wor became known in foreign countries, from whic valuable material was entrusted to him for researc He found cystercoids in copepods, and their stud brought him to that of the complicated cycles of t evolution of helminthes, and so he became a co-edit of the *Journal of Parasitology* and a member of t Helminthological Society of Washington. He i vestigated also the Sporozoa, Planariæ, Oligochæt and studied very deeply the life of ants, all work great exactitude, and discovered fresh-water Neme tines in Bohemia, as well as the only representative subtropical Temnocephalids in the Lake of Scutar His beautiful drawings appear frequently in the larg works on cytology. Mrázek was a modern zoologi who was a master of the problems of his time, not one-sided systematist or a mere morphologist. H work touched also problems of variability, heredity acquired characters, regeneration, and he devoted good deal of his time to the study of the relation between the organism and the medium in which lives, to ecology.

Mrázek was a splendid teacher, full of sacrific especially in laboratory work. He published a seri of popular lectures on the theory of evolution, and tran lated Romanes' work, "Darwin and after Darwin." He founded a small but pretty aquarium in his institut which is visited by thousands of students and othe people. While still living, he presented to his institut his rich private library and all his instruments, et He was a member of the Bohemian Academy of Scienc and of the Royal Society of Bohemia. His death is great loss to our University.

Bohuslav Brauner.

We much regret to announce the death of Pro P. Natorp, emeritus professor of philosophy in th University of Marburg, author of "The Logic Foundations of the Exact Sciences," and leader o the neo-Kantian school, aged seventy.

Current Topics and Events.

THE East African Parliamentary Commission has started on its long journey, a journey fraught with great and manifold possibilities. If any assurance was needed that scientific matters would receive their fair share of attention, it is to be found in the fact that Major A. G. Church, a member of the Medical Research Council, is one of the Commissioners. No such assurance is, however, required, for Mr. W. Ormsby-Gore, the chairman, is fully alive to the important part which scientific knowledge plays, and must continue to play, in the development of our tropical possessions. He has not forgotten the lessons learned in the West Indies, and realises that many of the same problems will be found in East Africa, together with others peculiar to what was once called the Dark Continent. Indeed, he and those with him are well aware that it is in the main owing to the triumphs of science that the old opprobrious title is no longer wholly applicable, but they are also persuaded that much more light requires to be shed on many difficult questions before the darkness which at present enshrouds them can be fully dispelled. Human, animal, and plant diseases will all engage their attention. All three are closely linked, perhaps more closely linked in Africa than anywhere else in the world. Examples come readily to mind: there is human sleeping sickness and animal trypanosomiasis, which the Commissioners will find in every territory they visit, and one thinks also of the calamity of a heavy aphis infection of millet and the famine which may follow it, and of the desolation which locusts leave in their track and the dire effects of their inroad upon both man and beast.

WHILE certain human diseases—as, for example, sleeping sickness, malaria, tuberculosis, leprosy, dysentery, yaws, the venereal complaints, and so forth—will be found common to all the countries in which the East African Parliamentary Commission will prosecute its inquiries, there are others to which the Commissioners' attention will be particularly directed in certain localities. In Northern Rhodesia there have been many cases of splenic abscess amongst natives, an obscure condition requiring research; plague merits special attention in Nyasaland and Kenya Colony; while in Uganda cerebro-spinal fever causes many deaths amongst natives. Again, some of the general diseases are more serious in certain territories than in others. Yaws is a crippling force in Kenya, syphilis a devastating disaster in Uganda. All these questions will require consideration, as will those of native hygiene generally, a subject intimately bound up with housing conditions and therefore with technical education. Veterinary problems abound, and in connexion with them and with many plant diseases the necessity for entomological research will be apparent, as indeed is also the case with respect to human pathology. It will be seen that on the scientific side alone there will be plenty to engage the Commission's attention. It cannot deal with details, but if it grasps some of the great underlying principles and speaks eventually with authority as to the necessity of increased facilities for education and research and for coping with disease and death, it will not have travelled and laboured in vain.

THE Government has decided to proceed at once with certain preliminary investigations in order to ascertain the feasibility of the scheme for using the tidal power of the River Severn for the production of electrical power by the erection of a barrage across the river. Lord Parmoor, to whose scientific department (the Department of Scientific and Industrial Research) the work has been entrusted, has already made arrangements to put it in hand. The Lord President of the Council has appointed the following Committee to supervise and direct the work:—Mr. G. S. Albright (chairman), Prof. A. H. Gibson, Mr. G. W. Lamplugh, Mr. Maurice Wilson, and Dr. J. S. Flett. The feasibility of the Severn scheme turns upon the possibility of finding satisfactory foundations for a barrage. Accordingly the first stage of the investigation will involve:—(*a*) The study by the Geological Survey of the stratigraphical formations in the neighbourhood of the sites suggested for the erection of the barrage; (*b*) taking preliminary soundings with the view of determining the contour of the river-bed at the sites; and (*c*) preliminary measurements of the flow of water at different states of the tide. Meanwhile, two eminent consulting engineers, Sir Maurice Fitzmaurice and Sir John Purser Griffith, have been invited by the Lord President to submit a joint report before the end of this year as to the possibility of constructing a barrage on one or more of the sites suggested on the assumption that safe foundations exist. The data which will be provided as a result of the geological and hydrographical investigations will be placed at their disposal. The staff of the Geological Survey has already begun the inquiry, and a report will probably be ready for submission to the Committee before the end of September.

BETWEEN 11 and 12 P.M. on August 22, a slight earthquake (intensity 4, Rossi-Forel scale), which lasted about six seconds, and was followed by another after an interval of about a minute, was felt in Inverness-shire, at Gairlochy, Spean Bridge and Roy Bridge, all within a few miles of the Great Glen fault. This fault, which runs from Tarbat Ness and crosses Scotland along the line of the Great Glen, has given rise to earthquakes in several parts of its course. Shocks are strongest and most frequent in the section between Inverness and the north-east end of Loch Ness, the last series being those of 1901. From 1870 to 1906, at least seven shocks occurred in the neighbourhood of Fort William, and it is possible that the strong Oban earthquakes of 1880 and 1907, as well as other slighter movements farther to the south-west, were connected with this fault. But, so far as known, this is the first time that an earthquake has originated near the south-west end of Loch Lochy

We are interested to learn that Mr. Joseph F. Rock, head of the National Geographic Society's expedition into Yunnan, S.W. Szechuan and S.E. Tibet, has recently returned to the United States after eighteen months in the field. He reports the finding of aboriginal tribes in China practising religious ceremonies which existed before Buddhism was introduced into either China or Tibet. He also brought back important plant and bird collections, the herbarium specimens numbering some 12,000 specimens. The plants were collected in the extreme north-west of Yunnan, Tsarong, south-eastern Tibet, the independent Lama Kingdom of Mili and also in eastern Yunnan. The birds collected number about 1600, and are from regions where few collections had previously been made. The collection contains land and water birds, and in addition a few hundred mammals. The birds and mammals will be presented to the Smithsonian Institution. Chestnuts of apparently immune species were found which may prove of value in the United States where the chestnut disease has wrought such havoc. Mr. Rock's chestnut introduction should prove of great interest to the tanning industry in the United States, which has depended upon chestnut to a great extent and has recently faced the possibility of this supply being destroyed through the ravages of blight. A fine set of firs, spruces, hemlocks, pines and junipers were also brought back. A large collection of rhododendron seeds was made, amounting, it is stated, to 493 kinds, and specimens of many of the rhododendrons as well as seeds of these and of Alpine plants have been sent to Kew and to Edinburgh.

In his presidential address to the Society for Psychical Research, just published, Mr. J. G. Piddington emphasised the difference between the certainty of astronomical predictions and the certainty of the psychical phenomena studied by the Society by saying that the Astronomer Royal, if he wished, could safely wager 5000*l.* to 1*l.* that an eclipse would take place at a certain time, whereas no such wager would be safe in, say, a case of alleged telepathy or clairvoyance. The comparative immunity from such uncertainty enjoyed by most men of science, he said, might actually disqualify them from being the best judges of the Society's work. The best policy would be to aim at convincing the average educated person. One of the difficulties lay in the fact that every science tended to become more and more complex, and those members of the Society who did not keep pace with the development of their methods were inclined to lose interest in their proceedings. Thus the latest automatic writings of some of their members were a sort of elaborate and extensive mosaic, a galaxy of cross-correspondences. In Mr. Piddington's opinion, this greater complexity arose from *someone's* intelligent design, though he would not venture to trace the intelligence which was deliberately complicating some of the phenomena investigated by the Society. The greater danger was a wave of credulity and superstition. The cause of psychical research stood to lose more through the credulity of the crowd than through its indifference or its scepticism.

The Council of the Zoological Society of Lond has instituted an Aquarium Research Fellowsh of the annual value of 350*l.*, tenable for one ye but with the expectation of reappointment for t further years if satisfactory progress is being mad The Research Fellow will be expected to give h whole time to his investigations, which will be carri out chiefly at the Aquarium in the Zoological Garde The object of the research is study of the conditio which affect the life of the organisms living in a aquarium, and not the anatomy, physiology, or lif histories of individual organisms. Candidates shou be recent graduates in honours in some branch science, and should be recommended as likely carry on research on independent lines. Experien of marine or fresh-water zoology is not require Inquiries should be addressed to the Secretar Zoological Society of London, Regent's Park, Londo N.W.8. It is not expected that an appointme will be made before October 15.

Dr. Fraser Harris, acting on medical advice, h resigned the professorship of physiology in Dalhous University, Halifax, Nova Scotia, which he has he since 1911.

During last week, an unusual contest was progress at the Crystal Palace, where Mr. C. V Hart pitted himself against a horse, Saucy Lassi in an endurance test. The test, which was to s which could cover the greater distance in six da came to an end on Saturday, August 23, when t total distances covered were: The man, 345 mil 880 yards; the horse, 337 miles 1618 yards. M Hart was thus the winner by 7 miles 1022 yards.

A physicist is required under the directorate radiological research of the Research Departmen Woolwich. Candidates must possess an honou degree in physics and at least three years' experien in research. Applications in writing, with tes monials and references to published work, should made to the Chief Superintendent, Research Depar ment, Woolwich, S.E.18.

Dr. W. J. Humphreys, of the U.S. Weath Bureau, Washington, would be glad if any observe of "ball lightning" would send him a comple description of the phenomenon with the followi details: date, witnesses, geographical position, tim during the storm, size, shape, sharp or blurry outlin whether with or independent of wind, direction motion (vertical, inclined or horizontal), kind motion (smooth or jumpy), effects produced, indoo or outdoors, and if the former how it entered.

A preliminary programme has now been issue of the centenary celebration of the Franklin Institu and the inauguration celebration of the Bart Research Foundation, to be held in Philadelphia September 17-19. The Franklin Institute has help in no small measure in the prosecution of researc into physical science and its applications during th past hundred years, and a noteworthy gathering physicists and engineers from both sides of th Atlantic is being brought together to celebrate th

niversary. Among the British men of science who e to deliver addresses are Sir Ernest Rutherford, r William Bragg, Prof. W. L. Bragg, Prof. E. G. ker, Prof. F. G. Donnan, Sir Charles Parsons, and of. J. S. E. Townsend. Other distinguished men science, exclusive of the large body of Americans, ho will be present, include Prof. Charles Fabry, of. F. Haber, Prof. W. Lash Miller, and Prof. P. eman.

THE southern slope of the Grasberg, in the valley the Dürren Ager, parish of Oberaschau, Austria, s been in motion. Portions of the forest have igrated to the valley, and landowners can no longer ientify their own areas. One man has a piece of rest tipped on him, but the timber is not his; nother has lost the meadows he intended to mow; ey have slidden away. The area of the landslide about 100 acres and is a quarter mile broad. The pth of the mass moved is not more than 50 feet, t it is not limited to the weathered surface. The hole slope has been soaked. Coloured or black ays and shales, dark grey "ruschel"-shales, interstratified between sandstones of the upper chalk, seem specially suitable for landslides. Two rows of stakes have been driven in so that measurements can be made to follow the movement.

WE learn that arrangements have been made by which Automatic and Electric Furnaces, Ltd., 17 Victoria Street, London, S.W.1, and Electric Furnace Company, Ltd., Elecfurn Works, 173-175 Farringdon Road, London, E.C.1, will jointly design Wild-Barfield internally heated electric furnaces having an input greater than 25 kw., which in future will be supplied by the latter firm. Automatic and Electric Furnaces, Ltd., will continue the manufacture and sale of the Wild-Barfield automatic hardening furnaces with magnetic detector, and internally heated type of furnaces up to 25 kw. Arrangements have also been made with George J. Hagan Co., of Pittsburg, U.S.A., who have constructed a large number of electric resistance furnaces up to 350 kw. capacity, for the use of their drawings and information, so that the best British and American practice will be incorporated in the designs.

Our Astronomical Column.

SOLAR SPECTROGRAPH FOR THE POULKOVO OBSERVATORY.—*Engineering* for July 18 contains a detailed escription and several photographs of the 7-metre lar spectrograph by Grubb, which has just been ected at the Poulkovo Observatory. The instruent, in which a grating is employed, is of the Littrow pe, and is modelled on the 30 ft. tower spectrograph Mount Wilson. The sun's rays are received on a elostat, for which a special erection is made at the p of the south wall of the Observatory, and are flected into an object-glass, after passing through hich they are reflected to the slit of the spectrograph the ground floor, where they form an image of the n about 10 cm. in diameter. The main object of e instrument is the study of the sun's rotation by eans of the Doppler effect shown by light from the stern and western limbs. By using a system of ur prisms, light from the centre and limbs of the n is made to fall simultaneously on different parts the slit, and the spectra are obtained in juxtaposition on a plate 24 cm. long by 4 cm. wide. The ectrograph lens has an aperture of 10 cm. and a cal length of 706 cm. No description of the grating given, but it is stated that the instrument will ve from one spectrogram a velocity measurement greater accuracy than 1/10th of a kilometre per cond in the line of sight. Arrangements are proded for rotating the instrument, the solar image maining fixed. The cœlostat, which has an erture of 25 cm., has been made adjustable for any titude between 60° and 37°, in order that it may be ed at the Simeis Observatory, in the Crimea, if sired.

THE LIVERPOOL ASTRONOMICAL SOCIETY, ANNUAL EPORT, 1923–24.—This body has undergone remarkble vicissitudes. It was founded in 1881 by Espin, aac Roberts, and R. C. Johnson, and proved so eful in helping beginners, and amateurs generally, at in a few years its membership rose to nearly 1000. hen a period of stagnation set in, and the publication its journal became very irregular. It was the alisation of its earlier usefulness that led to the formation of the British Astronomical Association in 1890. The competition thus afforded led to a distinct revival of the Liverpool body, though it has since been a local rather than a national body. War difficulties once more led to a suspension, but all will be glad to hear that meetings have now been resumed and that the outlook is hopeful. Papers were read during the session by the president (Dr. Whichello); by Mr. W. Porthouse on the moon; Mr. J. Rice on relativity; Rev. A. L. Cortie, S.J., on sun-spots and magnetism; and others.

While not at all endorsing the president's statement that the B.A.A. is too much under the influence of the professional astronomer to be of use to the ordinary amateur worker, we may freely admit that it is a great benefit to astronomers at a distance from London to have their own meetings both for discussion and observation; and doubtless all will join in wishing this society, the name of which recalls happy memories to many of us, a new lease of useful life.

ANNUAIRE DE L'OBSERVATOIRE ROYAL DE BELGIQUE, 1925.—This useful annual contains the usual almanac information about sun, moon, planets, stars, tides, etc. It gives very full information about wireless time-signals, and time determination. Incidentally it notes that while most of the national ephemerides adopt the new system of commencing the astronomical day at midnight at the beginning of 1925, the Berliner Jahrbuch adheres to the old system. It will therefore be necessary to state the system employed fully and clearly in all astronomical time determinations: it will be unwise to use the phrase Greenwich Mean Time for the new system without some distinguishing mark: Greenwich Civil Time is probably the best to use, but a warning is necessary that it does not mean Summer Time.

An error may be noted in the table of Periodic Comets on p. 168. The period given for Tuttle's Comet, 12·15 years, is far too short. The next return should be given as May 1926, not February 1937. Also the Comet Grigg-Skjellerup should be included as due to return in 1927.

Research Items.

SHORT CIST BURIAL IN KINCARDINESHIRE.—A short stone cist unearthed at Catterline, Kincardineshire, in March 1923, contained a fairly perfect male human skeleton which has been carefully examined by Prof. R. W. Reid and recorded by him and Rev. J. R. Fraser (Proc. Soc. Antiq. Scot., ser. 5, vol. x., 1923-24, pp. 27-40). The discovery revealed several unusual features. The covering of the cist, instead of being formed of a single series of large stones as is usual, was made up of several layers definitely arranged and graded, and embedded in sand three feet deep from top of bottom. One of the larger of the cover stones bore rude incisions in spiral and concentric circle form, but the weathering of the stone showed these were clearly handiwork of a much older date, and were not used as the artist had intended. Another of the cover stones was artificially perforated. The skeleton showed the ordinary characteristics of the round-headed bronze age race of north-eastern Scotland, with strongly platymeric limbs, but the skull capacity was unusually large, 1600 c.c., as against an average of 1458 c.c. for a considerable series of short cist skulls from the same region. The height of the individual was also out of the ordinary for his race, his stature, calculated from the leg bones, being 5 feet 10 inches, and calculated from the arm bones, 5 feet 8 or 9 inches. It would appear, however, that his arms were shorter in proportion to his legs than is the case in modern races. The average height of the short cist men of Aberdeenshire is only 5 feet 4 inches. The skeleton was accompanied by a low-rimmed clay beaker of the "drinking-cup" type, and by a fragmentary and rudely chipped quartzite pebble.

BIOCHEMISTRY IN INDIAN AGRICULTURE.—The Journal of the Indian Institute of Science, vol. vii. parts ii. and iii., contains two papers dealing with problems of considerable interest in connexion with Indian agriculture. In the first, G. J. Fowler and Y. N. Kotwal show, by a series of laboratory experiments, that dilute aqueous solutions of ammonium nitrite are not decomposed by other substances such as acids, amino-compounds, or hydrogen sulphide, which are likely to occur with them in ordinary agricultural or sewage disposal practice. Such loss of nitrogen as occurs in these operations cannot, therefore, be due, to any noticeable extent, to purely chemical reactions, but must be mainly the result of biochemical changes, as has indeed been generally assumed. The second paper deals with the retting of coconut husk for the production of coir. Coir is the fibre used in the production of coconut matting, and is therefore the basis of a large industry. So far as scientific investigation is concerned, it has been even more neglected than most of the coarse textile fibres, and Messrs. G. J. Fowler and F. Marsden are breaking new ground in tackling the problem. The fibre is obtained by soaking in water, which is changed from time to time for about ten months, the crude mass of fibrous tissue (mesocarp) which forms the husk of the fruit of the coconut palm. The natives who carry on this part of the industry have a good deal of rather indefinite and sometimes contradictory information as to the influence of various factors, such as the degree of ripeness of the fruit, the use of much or little water, the character of the water, and especially its salinity, on the quality of the fibre produced. Messrs. Fowler and Marsden find that the essential feature of the soaking process is the breaking down by bacterial agency of the material, described as insoluble gum or possibly a hemicellulose, which binds the fibre together in the husk. The necessary bacteri occur in the husk itself, and they remain active s long as the water is changed frequently enough t prevent them being poisoned by the products of th reactions they cause. The discoloration of the coi which sometimes occurs is due to changes in th tannin originally present in the husk, and the tannin under unsatisfactory conditions of soaking, ma oxidise to red insoluble products, which are deposite on the fibre, or if ferruginous water gains admittanc to the soaking areas, may form iron tannate, pro ducing "blue" fibre.

A NEW CERCARIA FROM NORTHERN INDIA.—Dr. B Soparkar describes (*Indian Journ. Med. Res.*, vol. xi. 1924) a new cercaria from northern India whic presents several unusual features. The tail is forke distally, and bears proximally two arm-like latera processes each terminating in an oval structure whic appears to be glandular and to serve as an organ c adhesion. The reproductive organs are much mor developed than is usual—the ovary and two lobulate testes being clearly marked, and numerous motil spermatozoa could be seen in the vesicula seminalis The entire length of the main excretory canal i ciliated. This cercaria develops in rediæ in *Melanoide tuberculatus*, but its further history after issuing fro the snail is unknown. The cercaria has not bee observed to encyst and it does not possess cysto genous glands; as it is not adapted for active penetra tion, the author suggests it is swallowed by the nex host.

INTERACTIONS OF PROTOPLASMIC MASSES IN *ARCELL POLYPORA*.—Bruce D. Reynolds (*Biol. Bull.*, vol. 4 Feb. 1924) finds that, like Difflugia, Arcella will, i favourable circumstances, reappropriate by fusio fragments of protoplasm which have been detache from it. Arcella is not attracted by a pseudopodia fragment of Difflugia, and if accidental contact i made the fragment is treated as a mechanical obstruc tion. Fusion will take place between one individua of Arcella and a protoplasmic fragment of a closel related specimen. Two distantly related individua which have not been kept in the same receptacle wi be attracted by each other's severed pseudopodia but upon making contact the protoplasm involve will be shattered into bead-like masses. When tw lines of a clone (a pure line) are kept under simila environments, cross-fusions between them cease aft about 22 days, but if the two diverging lines are kep under different environments, cross-fusions ceas after a shorter time—6 to 16·5 days. When sma quantities of culture media are frequently inte changed between the hollowed slides in which th members of two diverging lines are kept, cros fusions apparently continue indefinitely. When tw related specimens have become negative to eac other's protoplasm, cross-fusions between their pr geny may be induced by exchanging small quantitie of culture media or by placing them in the sam culture medium (time required, 6 days). Physic logical changes occur among the descendants of single Arcella reproducing vegetatively, but suc differences are probably due to environmenta influences rather than to hereditary variations.

EXPLOSIONS AND ZONES OF SILENCE.—Accordin to M. L. Gazaud's observations of the explosions a La Courtine on May 15, 23, and 25 made near Ma seilles, the zone of direct audition is very limited i extent (*Comptes rendus*, Paris Acad. of Sci., July 28

The explosions were in each case inaudible at the stations calculated from the distance, and the same was true at Montpellier. The explosion of May 15, however, was distinctly registered at both stations, but with retardations corresponding to extra paths of 70 and 135 km. respectively, the distance in a straight line from La Courtine being 360 km. At the same time a thick mass of cumulus cloud was observed, rising above the mountain masses of Ventoux and the Basses Alpes, forming an obstacle which was evidently quite capable of reflecting sound waves coming from La Courtine. Such a wall of cloud, if it were concave in front, could concentrate the sound waves so as to make them audible at certain points. A simple calculation of the probable trajectories for the two stations confirmed the above hypothesis, and fixed the probable points at the edge of the cloud mass where the sound was reflected. Reflection from above is shown to have been impossible in these cases, and that the height required to give such large differences of path, the pressure of the air would be very small, and very little sound would be transmitted.

NATURAL GAS INDUSTRY.—Three advance chapters of the Mineral Resources of the United States, volume for 1922, dealing with Natural Gas, Natural Gas Gasoline and Carbon Black produced from Natural Gas, contain significant data proving the rapid development of this industry in America. Consumption of natural gas in 1922 amounted in the United States to 762,546,000,000 cubic feet, being 15 per cent. more than the quantity used in the previous year. West Virginia, Oklahoma, and Pennsylvania ranked chief among the twenty-three producing States, each giving over 100,000,000,000 cubic feet, showing that the palæozoic compared with the tertiary fields are still the most important from the point of view of gas production. The unit value of the gas has also gradually increased, the average at points of consumption being 29·1 cents per 1000 cubic feet compared with 21·6 cents in 1919; the value in domestic consumption shows proportionate increase, being 49·9 cents per 1000 cubic feet in 1922. Unblended gasoline extracted from natural gas in the year under review amounted to 505,832,000 gallons, representing a 12 per cent. increase over the previous year and 8 per cent. of the total gasoline produced in America from all sources. The average yield of gasoline per 1000 cubic feet of gas thus works out at 0·9 gallon. Of the 917 plants in operation for the extraction of this product throughout the United States, those of the compression type produced by far the largest amount of gasoline, though statistics show that the combination process is steadily increasing in favour. The average value per gallon of natural gas gasoline was 14·4 cents in 1922. Carbon black manufacture likewise showed an increase of 1 per cent. over the previous year, amounting in 1922 to 67,795,000 pounds; the advance was largely due to the greater demand for this commodity in the rubber tyre industry. Louisiana and West Virginia together were responsible for more than 90 per cent. of the entire output of the country, the Monroe field of the former State contributing in no small measure to this result. The average price per pound of carbon black was maintained at 8·6 cents, a slight increase compared with 1921.

ACOUSTICS OF HALLS.—Owing to the pioneer investigations of the late Prof. Sabine, the factors which determine the acoustical properties of rooms are becoming known, and the provisional theory is being tested by the observations made in halls of various sizes and shapes by auditors whose opinions are of value. As the result of a considerable amount of work of this kind, Prof. F. R. Watson, of the University of Illinois, suggests in the July issue of the Journal of the Franklin Institute an improvement in the law expressing the best time of reverberation in a hall in terms of its volume. His expression for a hall without audience is, time in seconds $= 0{\cdot}75 + 0{\cdot}375\sqrt[3]{\text{volume}}$, the volume being in cubic feet. He concludes also that in increasing the absorbing material as the hall gets larger, it is best to keep the average absorption per unit area constant. This involves the energy of the sound source being proportional to the area of the surface of the hall.

THE QUANTUM THEORY OF RADIOACTIVE DISINTEGRATION.—In an article in the *Zeitschrift für Physik* of August 4, Dr. A. Smekal shows that the quantum mechanism proposed by him in 1922 gives a complete explanation, on the lines of the Bohr theory, of all the β-ray spectra which have so far been determined with certainty. Rosseland's criticism of this mechanism is ungrounded, and it is shown that he has simply applied the views of the author to explain the continuous β-ray spectrum of a very special class of β-ray disintegrations. The close analogy between X-ray and β-ray spectra supplies an explanation of the relationships found by Ellis and Skinner between the sequence of the nuclear levels in radium B and radium C. Wentzel has shown that "spark" lines are found in the X-ray spectrum, due to multiple ionisation, the terms of which bear a definite relationship to those of the normal lines. In a β-radioactive atom, instead of a recombination of an electron, as for X-rays, an electron is given off from the nucleus, or moved to an outer orbit. If two β-radiators follow one another in the periodic system, there is a close analogy with the case of a non-radioactive atom which has lost both its K electrons, and in regaining them will give spark lines, as well as the normal X-ray spectrum.

X-RAY ABSORPTION SPECTRA.—New measurements have been made of the fine structure of the K absorption band head of Ti, V, Cr, and Mn, and of the L_{III} band head of Sn, Sb, Te, and I, by Dr. D. Coster, *Zeitschrift für Physik*, July 2, and it is shown that the character of the structure depends on the chemical state of the element concerned. When the valency of the element in the compound used is high, an absorption line, Ka, $L_{III}a$, is found on the long wave-length (soft) side of the band head, but not for compounds in which the element has a low valency. It is thought that the principal band head corresponds to the sudden rise, from zero to a maximum value, of the probability for the removal of an electron from the layer concerned to infinity, when the wave-length diminishes to a particular value; the lines Ka and $L_{III}a$ are probably due to the removal of the electron to an inner electronic layer. The principal band head approaches the position of the Ka or $L_{III}a$ line as the chemical state of the element approaches that of the uncombined gaseous element. It may very well be that the lines Ka and $L_{III}a$ really exist in all cases, but can only be observed when the separation from the principal band head is sufficient. The author deals with the theory of this shifting of the band head and with that of the maxima and minima of absorption observed on the "hard" side of the band head. It is suggested that, in this region of the spectrum, besides the "photo" effect, there is another possibility, so that the atom may take up a larger energy quantum than that corresponding to the removal of an inner electron to infinity; the extra energy might be used in removing an electron simultaneously from

the outer layer; or the atom or atomic complex may be in some special state of tension after the absorption.

FIRST LAW OF PHOTOCHEMISTRY.—The Journal of the Chemical Society for July contains an important paper by Mrs. M. C. C. Chapman on the first law of photochemistry. This law, which was enunciated by Draper in 1843, states that the amount of chemical change in a given system effected by light of a specified wave-length is proportional to the light absorbed. Although this is a fundamental principle of great importance, its validity has not been conclusively established. Its accuracy has, in fact, recently been challenged by Baly and Barker, who found that in the case of the combination of hydrogen and chlorine, when the light intensity was increased in the ratio of 1 : 6, the rate of combination increased in the ratio of 1 : 10. Mrs. Chapman has carried out careful experiments with the same reaction, and the results show that the rate of combination appears, if anything, to increase with the light intensity rather less rapidly than is required by Draper's law. For the ratio of intensities 1 : 6, the ratio of rates of combination was 5·49 in one group of experiments and 5·67 in another. With six slits, the ratio of rates of combination occasioned by opening six slits compared with that with two slits was 1 : 2·97, 1 : 2·95, and 1 : 2·97. The deviation from Draper's law is ascribed to the temporary reduction in pressure of the water vapour occasioned by the formation of hydrogen chloride rather than to an inhibitive action of hydrogen chloride. The experiments were made in the presence of water. The conclusion reached is that the abnormal result obtained by Baly and Barker could not be substantiated, and that Draper's law is valid even in the case of the photochemical change which exhibits the greatest departure from Einstein's law of photochemical equivalence.

BAKERY RESEARCH.—A report on research work carried out at the National Bakery School, London, has recently been issued by Dr. C. Dorée and Mr. John Kirkland. It is divided into four sections, namely, (1) variation in weight of loaves due to loss in baking, (2) weight conserving effects of wrapping loaves in waxed paper, (3) variableness of oven temperatures, (4) quicker ripening of hard flour doughs. With respect to the first part of the report, the opening paragraph quotes the Report of the Inter-departmental Committee on the Sale of Bread by Weight which stated that, in spite of the difficulties encountered, it is possible to estimate with reasonable accuracy the loss which takes place in baking and after. The sale of bread by weight places the baker in a very difficult position, as it has been suggested that it is by no means easy to tell how much dough should be scaled off so that the resultant cooled loaf should just be the desired weight. No conclusions are directly drawn contradictory to the committee's considered opinion, but the mass of carefully collected data in this report throws very grave doubts on its correctness. Loss of weight is found to be affected by the tightness of the dough, by the position in the oven, by the kind and shape of the loaf in question, by the degree of ripeness of the dough, by the length of time the bread is in the oven, and by the presence or absence of certain moisture pastes chiefly of a starchy character. It is further shown that attention to these points is a matter of considerable financial importance to the practical baker. The second part of the report dealing with the effect of wrapping on the weight of the loaf is very limited in scope, although the results are of interest. It is shown that the expense of wrapping is partly met by the decreased loss in weight of the loaf on keeping. There was u fortunately no work done on the important questio of the increased cleanliness of the loaf. As to th variableness of oven temperature, it appears that the is often a range of temperature in different parts the oven of 50° F., and in some cases of more tha 100° F. It may be that some of the rather incor sistent results reported in the first part of this repo are due to this varying factor. The final part dea with the quicker ripening of certain hard and stron doughs. In view of modern labour conditions it necessary that something should be done to th stronger and slower ripening flours if they are to b ready for the oven quickly, and the practical sugge tion of the addition of lactic acid and the preparatio of pastes rich in lactic acids is made.

COAST DEFENCE WORKS.—The destructive effect the grinding action of shingle or boulders on concre structures erected on the foreshore is well known. D John S. Owens describes a method which has been use successfully on the south coast of England, and illu trates it with photographs in the *Engineer* for Augu 8. The method consists in facing the concrete s wall with wood blocks set in cement, with the en grain exposed. One of the photographs shows a experimental patch of wood blocks inserted in 192 and the wear of the unprotected surrounding concre has been from 1½ in. to 2 in. more than the woo The wood blocks indeed show but little signs of wea and it has been noticed that where a knot came the surface of the wood there was a definite hollo worn, the hard knot being worn more rapidly tha the surrounding soft wood. The experiments we regarded as so promising that a considerable leng of sea wall was faced this spring with wood block The blocks are mostly 6 in. square on the surfa and are set with headers 9 in. long at intervals, th other blocks being 6 in. deep. All the blocks we set in neat cement grout and were held in position the first instance by double-pointed nails, as one the difficulties encountered was to keep them correct position while the concrete behind was fille in and rammed.

LATERALLY LOADED STRUTS.—Technologic Pap No. 258 of the U.S. Bureau of Standards contains a account of some tests on steel tubing made by M Tom W. Greene with the view of ascertaining wheth experimental results confirmed the theory of lateral loaded struts. The range covered the cases of column without transverse load to that of a bea with no column load. It was found that the ecce tricity due to variation in wall thickness and deviation from straightness is an important facto A modified rational formula based upon considerati of the effect of eccentricity was found to fit th experimental results very closely. Failure of a str will occur when the maximum compressive stre computed by the modified formula is approximate equal to the yield point, and the modified ration formula reduces to the "secant" column formu when the transverse load is equated to zero. reasonably accurate computation of the stress in laterally loaded strut can be made by summing th bending stress due to the transverse load and th column stress obtained by the "secant" formula, pr vided that in the latter formula the effective ecce tricity is taken as the sum of the original eccentricit (due to tube irregularities) and the deflexion of th strut at the centre resulting from the transverse loa The methods of measuring the eccentricities in th test struts are clearly described in the paper, an judging from the exactness of agreement shown b the checks applied, appear to be very accurate.

The International Commission on Illumination.

THE second technical session of the International Commission on Illumination was held in Geneva on July 21-25, under the presidency of Dr. E. P. Hyde (U.S.A.). About forty delegates from France, Great Britain, Italy, Switzerland, and the United States of America were present, while observers from Japan and Poland attended the meetings. The delegates were welcomed to Geneva by M. Stoessel, president of the city, while Dr. Carrozzi, representing the health section of the International Labour Office, welcomed the collaboration of the Commission in problems which were of particular interest to his section. The president announced that national committees were in the process of formation in Belgium and also in the Union of South Africa.

At the first technical meeting two papers dealing with primary standards of light were presented by E. Crittenden (U.S.A.), on behalf of Dr. Ives, and by M. Fleury (France). Dr. Ives, by using a cylindrical platinum black body at the instant of melting, has obtained results which are considered sufficiently reproducible to make this type of black body a suitable primary standard. His results indicate that at the melting-point of platinum the black body has a brightness of 55·4 candles per square centimetre, and its radiation very closely colour-matches that of the carbon filament lamps operated at 4 watts per mean horizontal candle, in which the international candle is maintained. M. Fleury is using a carbon tube furnace held at such a temperature that the intensity of the radiation between two given wavelengths is N times that between the same wavelengths emitted by a black body held at the melting-point of gold. The power consumed in the furnace, and hence its temperature, is maintained constant by the use of a thermionic valve controlling a generator, and it is anticipated that the constancy of temperature will be sufficiently exact to enable the furnace to be used as a primary standard of light. As a result of discussion the Commission passed a resolution recommending that the brightness of the black body operated under definite specified conditions be adopted as the primary standard of light, and that the various National Laboratories be asked to specify conditions and to determine its value in terms of the international candle at present in use. An exceedingly comprehensive paper dealing with the properties of tungsten and the characteristics of tungsten lamps was presented by Dr. Crittenden (U.S.A.) on behalf of Dr. Forsythe and Dr. Worthing. Other papers were concerned with the description of an acetylene standard lamp for use in sensitometry, and of special holders for electric lamps used as photometric substandards.

The second technical meeting was taken up with the study of problems in connexion with photometric definitions and symbols arising out of the report of the international committee on definitions and symbols, presented by M. Fabry (France) on behalf of M. Blondel, and the reports of the various national committees. A technical sub-committee was appointed to deal with the recommendations, and agreement was reached on about fourteen definitions, in addition to those on which agreement was reached at the Paris meeting in 1921. Definitions were finally adopted of transmission, absorption and reflection factors, brightness, visibility, total flux, mean spherical intensity, reduction factor, efficiency of a source, and several other quantities. Symbols for luminous flux, luminous intensity, illumination, and for transmission, absorption, and reflection were also agreed upon.

The Italian National Committee presented a vocabulary of illumination in Italian, and it was agreed that it would be advantageous if there were corresponding vocabularies in English, French, and German. As the Swiss National Committee had already placed on its programme the collation of the Italian and French vocabularies, it was decided that this work should be extended by including English and German, and it was decided that a sub-committee with a Swiss chairman should be appointed to deal with the matter.

The third technical meeting opened with a paper by Prof. Fabry (France), chairman of the sub-committee on heterochromatic photometry, appointed at the Paris meeting. Prof. Fabry gave an excellent account of the work done since the Paris meeting on the subject of heterochromatic photometry, and of a programme of work which, if carried out by the sub-committee, would be of the greatest value. A paper was presented by Mr. H. Buckley (Great Britain) on behalf of Messrs. Buckley, Collier, and Brookes on the colour temperature scale for tungsten. Very satisfactory agreement with existing data was obtained in this preliminary work, which it is intended to repeat to greater accuracy. M. Jouaust (France) read an interesting paper on the use of absorbing screens in heterochromatic photometry. Dr. Crittenden (U.S.A.) presented a report on behalf of Mr. K. S. Gibson on the relative visibility function. This report reviewed the more recent work on this problem, including that by Messrs. Gibson and Tyndall, in which the step by step method of direct comparison of different portions of the spectrum was used. It appears from this work that, contrary to what had been suspected, the direct comparison method gives the same results as those obtained by methods involving flicker photometry. The Commission passed a resolution that the values recommended by Mr. Gibson should be adopted as provisional standard values of the visibility factor, except in certain specified cases such as arise in considering the ends of the spectrum or in particular conditions of field intensity and size. These new values differ only slightly from those recommended at the Paris meeting in 1921. The Commission decided at this meeting that the sub-committee on heterochromatic photometry should extend its activities to include the investigation of the transmission characteristics and the specification of coloured glasses, particularly of those glasses used in photometric measurements. It was also decided that a new committee consisting of three members should be set up to deal with colorimetry.

The fourth technical meeting dealt with street lighting and with certain aspects of illumination engineering practice. Mr. H. T. Harrison (Great Britain) presented a paper in which he developed the idea that street lighting should be more of the projection type, such as is associated with automobile headlights. Papers were also presented on street lighting in Paris by gas and electricity, and on some interesting traffic regulating signs recently installed in Paris. A proposal was made that the Commission should recommend the fixing of a legal minimum of illumination for street lighting. It was decided, however, that though it might be desirable for the Commission to give the weight of its opinion on street lighting, this was such a debatable subject that action had better be deferred pending further consideration, and it was agreed that at the next meeting the question of street lighting should be given greater prominence.

The papers on illumination engineering practice were the first of their kind which had been given before the Commission. In these, the authors, Messrs. Lieb, Merrill, and Powell (U.S.A.), gave an account of some of the features of the organised campaign which is being carried on in America to promote the widespread practical application of the principles of good lighting. Dr. Lieb urged that the work of the Commission should not be restricted merely to the theoretical aspects of illumination, but should be extended to include the practical aspects of illumination engineering so that it would be of benefit both to manufacturers and the general public. Mr. Merrill described the method of conducting good lighting demonstrations, while Mr. Powell described various types of propaganda work, and surveyed a large field of investigatory work in practical illumination engineering.

The fifth technical meeting dealt with factory and school lighting and with automobile headlights. Mr. L. B. Marks (U.S.A.) presented the report of the international sub-committee on lighting in factories and schools as a basis of international agreement. Recommendations of the minimum illumination in various circumstances, of the maximum brightness of light sources, of exit and emergency lighting, and of the colour and finish of school interiors, were made. There was general agreement that at present standard minimum values of illumination for working conditions should not have any legal force, and that whatever regulations are made should be based solely on considerations of the health and safety of employees. Mr. Gaster (Great Britain) presented a paper on some further developments in industrial lighting in England, and M. Bordoni (Italy) on some phenomena of glare. Dr. Sharp (U.S.A.), chairman of the international sub-committee on automobile headlights, presented a report in which the propos made by each of the various countries were reviewe while papers dealing with the photometry of au mobile headlights were presented by Messrs. Bos and Cellerier (France).

After the technical meetings were over a plena meeting of the Commission re-elected Dr. E. P. Hy to the office of president for the next three yea Mr. C. C. Paterson was also re-elected to the office honorary secretary and treasurer, and Mess Edgcumbe (Great Britain), Rouland (France), a Semenza (Italy) as vice-presidents, while Mr. Wal of the National Physical Laboratory, to whose abili and efforts the technical success of the meeting w so largely due, will continue his work as gene secretary for the next three years. It was provisio ally decided that the next meeting should take pla in the United States of America in 1927.

The meetings were held in the Palais Eynard, whi was kindly placed at the disposal of the Commissi by the City of Geneva. The delegates were ent tained at a motor excursion and a dinner at Belleri on the evening of Tuesday, July 22, by the preside and members of the Geneva City Council; and at dinner at the Hotel des Bergues by the Swiss Natior Committee on Wednesday, July 23. On July 24 t Swiss National Committee were the guests of t foreign delegates at a dinner held at the Parc des Ea Vives.

The Swiss National Committee, particularly t president, M. Filliol, and the secretary, M. Largiard were responsible for the excellent arrangements ma for the meeting, while M. Thomas, the director of t International Labour Office, very kindly placed secretarial staff and interpreters at the disposal the Commission. H. B.

The Automatic Measurement of Atmospheric Pollution.[1]

By Dr. J. S. Owens.

THE suspended impurity in the air can be measured by two methods, the automatic recorder or filter, and the jet dust counter method. The former was designed primarily for measurement of smoke pollution, and depends upon filtration of the air through white filter paper, the resulting discoloured spot being compared with a calibrated scale of shades. In the dust counter method the results are independent of the colour of the particles, a count of their number as well as an examination of their size, shape, and nature being made microscopically. Curves showing the numerical value of the suspended impurity for different cities and its variation from hour to hour can be plotted from the average figures for a large number of days. The cities selected for this purpose were London, Rochdale, Blackburn, Glasgow, and Stoke-on-Trent.

The London curves of impurity for Westminster, Savoy Hill, and Kew Observatory indicate that the impurity is lowest between midnight and 6 A.M., after which it rises rapidly to a maximum between 9 and 10 A.M., falling again steadily until about 4 in the afternoon, when there is a tendency to rise slightly to a second but lower maximum. At about 10 P.M. the impurity falls away until about midnight. The Sunday curves are similar, but the maximum in the forenoon is not reached until about an hour later. The rise of impurity between 6 and 7 A.M. is attributed to the lighting of fires, the smoke from which is emitted in greatest quantity soon after lighting.

In plotting the curves referred to, it was found advisable to divide the days into two groups :

[1] Substance of a paper read before Section A (Mathematics and Physics) at the Toronto meeting of the British Association.

(*a*) Days in which there was much smoke ha at some time, as indicated by the automatic recorc showing a shade number equal to or above 4 equivalent to 1·28 mg. per cubic metre. These we referred to as " Z " days.

(*b*) Days of little smoke haze when the maximu did not reach Shade 4.

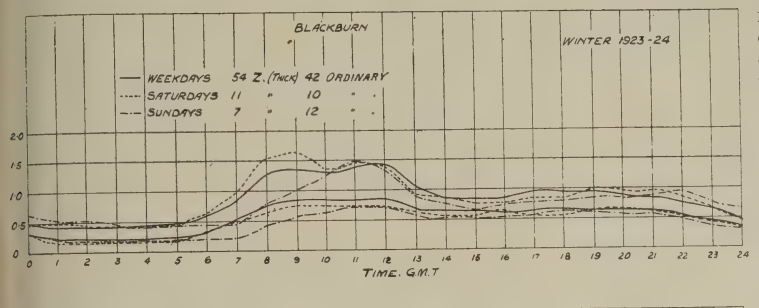
As the existence of thick smoke haze over a ci on certain days is due rather to failure of the natu processes by which normal smoke is removed produced, than to abnormal smoke production those days, this division is an attempt to separa ordinary days from those in which the ventilati fails, usually during anti-cyclones with light indefinite winds and inversion of the lapse rate.

The distribution of impurity for Rochdale a Glasgow is very similar to that in London. T records from Blackburn exhibit certain peculiariti These were prepared from an average of 269 da for the year 1923–24, 136 being winter—72 of whi ranked as " Z " days, that is, days of much smo haze.

The hourly distribution in Blackburn has certa important peculiarities; for example, a rapid r of impurity commences in the morning in the summ about 4 A.M., and reaches its maximum on wee days and Saturdays at 7 A.M., while on Sundays t maximum is not reached until 10 A.M. Again, the week-day and Saturday curves there is a seco maximum between 10 and 12 in the forenoon, high than the first, and separated from it by a 4-ho interval.

It is inferred from this that there are two ma sources of smoke, making their maxima at differe

nes. The Sunday curves show no evidence of a ouble maximum in the forenoon. It is therefore ferred that the first maximum is due to industrial d the second to domestic smoke. In support of is is the fact that in winter the second maximum higher than the first for week-days, while in summer e first is higher than the second. The relation



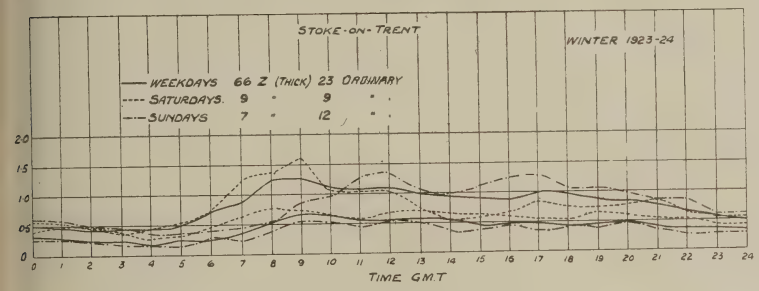


Fig. 1.—Suspended impurity in the air.

etween the total smoke emitted on Sundays and on week-days is as 2000 to 3077, based on the curves for rdinary winter days—not ranking as "Z" days. f the Sunday smoke be assumed to be domestic, nd the week-day smoke domestic plus factory, the atio of factory to domestic smoke becomes 1 : 1·85.

Stoke-on-Trent exhibits even more peculiarities han Blackburn. Stoke is a pottery ity containing about 2500 ovens. Records are available for a total of 22 days, including 126 winter days —82 of which ranked as "Z." Thus of the winter days recorded 65 per cent. had thick smoke haze, hat is, on two out of every three lays.

Fig. 1 shows that a definite rise egan about 4 A.M. on week-days nd 5 A.M. on Sundays. On summer week-days and Saturdays the maximum is reached between 7 and 8 A.M., while in the winter on week-days and Saturdays the maximum is between 8 and 9 A.M., and on Sundays about mid-day. In both summer and winter the impurity is maintained at a high level during the whole afternoon, but with remarkable oscillations, not shown in the records of the other cities mentioned. The minimum impurity is found at about 3 A.M.

The amount of suspended impurity in Stoke on ordinary winter Sundays is not much less than on week-days, the ratio being as 2022 to 2398. Here there are evidently conditions which make it impossible to apply the method already used for ascertaining the relation of factory to domestic smoke. In all the Stoke records for summer and winter, the Saturday maximum in the forenoon is the highest. This can be traced to the custom of lighting pottery ovens on Friday night or Saturday morning.

The incidence of atmospheric impurities on different days of the week has also been examined for six different cities, from which it appears that there is a general tendency to a minimum of smoke haze towards the end of the week, and a maximum about the beginning.

Since the records of the automatic instrument upon which the above conclusions were based depend upon the discoloration of a filter paper by the trapped impurity, experiments were made in which the results obtained with the dust counter method referred to were compared with those by the automatic recorder. In the latter, which was intended for recording city smoke, the impurity is assumed to be black, whereas the dust counter is independent of colour.

In the latter, fully described elsewhere,[2] the action depends upon the projection of a narrow ribbon-shaped jet of air against a microscope cover glass at such a velocity that a marked fall of pressure occurs with adiabatic expansion and cooling of the jet and consequent condensation of water, supplied from a damping chamber, upon the dust particles and the cover glass where the jet impinges. This results in the dust particles being projected against the cover glass by virtue of their greater density, and their increase of mass due to the condensed water. They adhere to the glass as the water evaporates, leaving a linear trace of dust, which can be examined microscopically and counted.

Simultaneous observations were taken with both instruments, and the results plotted in Fig. 2. From this curve it is evident that there is a reasonably constant relation between the number of

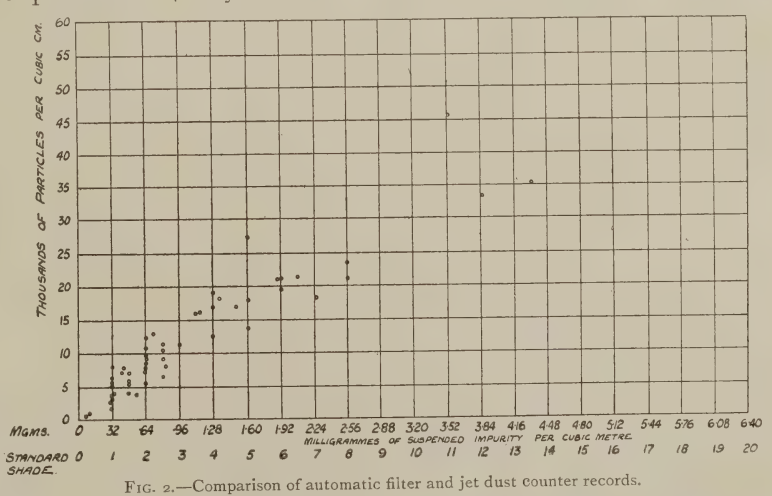

THOUSANDS OF PARTICLES PER CUBIC CM.
MGMS. 0 32 64 96 128 160 192 224 256 288 320 352 384 416 448 480 512 544 576 608 640
MILLIGRAMMES OF SUSPENDED IMPURITY PER CUBIC METRE.
STANDARD SHADE. 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Fig. 2.—Comparison of automatic filter and jet dust counter records.

particles per cubic centimetre, and the weight of impurity in milligrammes per cubic metre as given by the automatic recorder.

This indicates a tendency towards uniformity in size of the particles at different times, but there is also a definite departure from such uniformity during thick smoke haze when the average size increases, doubtless due to insufficient time for separation by

[2] Proc. Roy. Soc. A, vol. 101, 1922.

settlement. The maximum diameter of smoke particles in the absence of thick smoke haze is about 1½ microns, while during thick smoke haze the maximum reaches about 3 microns. Fig. 2 shows that the relation in London between number and weight of particles is usually such that 10,000 particles per c.c. corresponds to 1 mg. per cubic metre. It is not suggested that this relation holds good for all types of dust, but it shows that the automatic recorder gives trustworthy comparative results for city air, where the colour of the suspended particles is usually black.

Horticultural Research.

THE growing recognition of the importance of research work in connexion with the fruit industry is emphasised by the Annual Report issued by the National Fruit and Cider Institute at Long Ashton, Bristol. The year 1923 was the first since the outbreak of the War in which the work could be conducted under relatively settled and stable conditions, and it was marked by steady progress as regards both advisory and research work. The direct and practical bearing of the research work upon the current problems of fruit growers is very noticeable, and though many of the results are still preliminary or tentative, they open up suggestive lines for future progress.

The manurial experiments on fruit trees in pot cultures have been continued to study the effect upon growth of the omission of the various essential elements in turn. Leaf scorch affected many of the plants, but an increase in the amount of potash entirely prevented the development of scorch, while a reduction of nitrogen retarded it and reduced its amount. An examination of the root systems of various fruit trees shows that under many systems of planting there must be considerable overlapping of roots, introducing a serious element of competition which probably acts as a severe check to growth in many cases. This research is being continued in connexion with the danger of planting up orchards of large trees with soft fruit, if the latter is left too long on the ground. In connexion with the damage wrought by the apple blossom weevil it is pointed out that isolated efforts of control are unlikely to be efficacious, but that co-operative action is essential for success. Direct control methods must be associated with hygienic conditions in the fruit plantation, and a scheme of procedure is outlined, embracing a sequence of scraping, spraying, and banding the trunks, followed by the collection of capped blossoms in May. Other pathological investigations deal with egg-killing washes, the effect of sulphur on black currant mite, "red plant" in strawberries and its correlation with "cauliflower disease," purple leaf blotch of strawberry, and the infrequent disease of pear leaf blister.

A most interesting investigation is that of cold process fruit preserves. Under ordinary methods of preparation, jams, jellies, and fruit juices are subject to prolonged high temperature, to the detriment of their flavour, colour, and aroma. With the "cold" method the consistency of the product must be such that micro-organisms do not develop, a condition that can be secured by increasing the sugar content to 62-65 per cent., or less if the acidity of the fruit is high. Jellies and fruit juices give very satisfactory results, but more difficulty is experienced with the jams. Large-scale trials are being made to determine whether these methods are suitable for development under commercial conditions.

Another aspect of the work is shown by experiments on the "buffing" of willows, a process whereby, after prolonged boiling in water, a mineral-brown colour is imparted to the wood of willow rods. Freshly cut willow rods can only be peeled for a short time in the spring, owing to the rapid production of new wood which interferes with satisfactory peeling. "Buffed" rods can be peeled throughout the year, and the introduction of the process has been of great importance to the growers and to the basket industry. Improved methods are being sought and possibilities of industrial application worked out.

The chief lines of work at the Fruit and Cider Institute have been touched on above, but various other researches are being carried out, some of which may lead to more extended inquiries in the future, and others are of importance in their relation to the main investigations.

Problems of Human Nutrition.

THE investigation of human nutrition dealt with in the report before us[1] was undertaken in the autumn of 1922 during a period of depression for those engaged in the coal mining industry. Details regarding the actual food consumption were obtained from 140 families distributed in five different counties. The general result of the inquiry shows that though the average consumption of food in Derbyshire was sufficient for a healthy life when judged by accepted standards, the average diets in Northumberland, Lancashire, Stirlingshire, and in particular Durham were not so satisfactory. In the latter county the weight of the miners' children was slightly below the county average, though it seems probable that factors other than a deficient diet may have been partly responsible for this. The Committee is cautious in drawing conclusions, since the number of families investigated was not large, and it was recognised that the method adopted of reducing each family to the equivalent of "average men" for the purpose of assessing the nutritional value of the family diet is not free from objection.

The Committee has assumed that the average daily food requirement of a miner is equivalent to some 3400 calories. This figure has, however, not been ascertained by direct observation, but is inferred from a consideration of the numerous data already available on the energy output of man under different conditions of rest and work. Prof. K. N. Moss, in an investigation of the effects of high underground temperatures on the miner, has recently given details of the actual food consumption of a selected number of miners in different districts who had a high reputation for steadiness and industry. These figures show an average daily energy intake of well over 4000 calories, a value much in excess of that assumed by the Committee. Moss's selected subjects were clearly well above the general average, but if we regard the Committee's estimate as approximately true for this general average, it is apparent that there may be very great differences of energy expenditure between different individuals employed in the same industry. It is not alone the actual work done in the mine that matters, for much energy may be expended by the miner in walking to and from his work and in recreation in his spare time: as regards the last two items there is the possibility of great individual and local variations.

It is evident that further investigation is required regarding the actual energy output under everyday conditions not only of miners, but also of workmen in

[1] Medical Research Council. Reports of the Committee upon Quantitative Problems in Human Nutrition: Report on the Nutrition of Miners and their Families. Pp. 59. (London: H.M. Stationery Office, 1924.) 1s. 3d. net.

er industries involving heavy manual labour. So lg as uncertainty prevails as to the true energy quirements of the individual, the assessment of the ritional value of the family diet in the manner opted by the Committee cannot acquire its full ue. In times of financial stress the full diet of wage-earner may have to be maintained at the ense of other members of his family, and the ldren may in the end be the real sufferers. It is be hoped that the Report of the Committee is but prelude to further investigations which will dispel obscurity which still surrounds some of the portant practical problems of human nutrition. e work is bound to be very arduous, but it is worth ng, for apart from its value to the physiologist it s a direct bearing on modern economic questions.

Haddock Biology.

MR. HAROLD THOMPSON has made a useful contribution to our knowledge of the life-tory of the haddock in the report before us.[1] is fish is of increasing commercial value, and its undance fluctuates considerably from year to year. the researches which Mr. Thompson describes, he rtainly brings nearer the time when the causes of ese fluctuations will be better understood, and he reshadows the possibility of being able to predict two or three years ahead any special scarcity or undance of the fish in a particular area such as the rth Sea.

Great importance has been attached to the accurate termination of the age of the fish. For the haddock has long been recognised that the most trustworthy terminations of age can be got by studying the rkings on the scales. The author has, however, bjected the whole method of age determination in is fish by means of the scales to a minute and tical examination, and especially has been at great ins to study scales taken from many different parts the body. This careful but tedious examination s justified the methods employed, and the satis-tory conclusion has been reached, that if a few rmally shaped scales be taken from a haddock, it possible in about 95 per cent. of cases to read the e from the number of annual zones marked on em; and further, that by measuring these zones d comparing their length with the total length of e scale in each instance, one can calculate the sizes tained by the fish at the end of each previous year its life.

The author considers that North Sea haddock grow the average 17·5 cm. in the first year, though the nge of size is considerable, from 11 to 21 cm. The eatest growth in this, as in other years, takes place the autumn, and growth practically ceases in ovember, when the scale has formed about 22 rings clerites). The first scales make their appearance hen the fry are about 3 cm. long. In 1922 and 921, yearling haddock were sparsely represented in e North Sea, but the 1920 brood was extremely undant, as shown by the prolific numbers of one-ar-old fish in 1921 and two-year-old fish in 1922, the later months of which year they formed the ainstay of the Aberdeen market haddock supply. he year 1904 was a similar good brood year for addock and was followed by an abundant fishery of ree-year-old fish in 1907.

The rate of growth of the haddock varies in different gions. In the same latitude the best grown fish are found in shallower and warmer water, whereas there is a diminution in growth rate with increase of the depth from which they are captured. South Iceland and Faroe haddock exhibit faster growth than those captured in the North Sea and off the northern coasts of Scotland, for there favourable temperature conditions occur throughout the year, and the temperatures are so much less variable that it is often difficult to note the annual zones on the scales.

The paper is a valuable contribution to the literature of British fisheries.

[1] "Fishery Board for Scotland: Scientific Investigations, 1922. No. 5: roblems in Haddock Biology, with Special Reference to the Validity and tilisation of the Scale Theory. I: Preliminary Report." By Harold ompson. Pp. ii+28+3 plates. (Edinburgh and London: H.M. tationery Office, 1923.) 7s. net.

The Iron Ores of China.

THE widespread distribution of local iron smelting in China led to the general belief that China possesses some of the greatest reserves of iron ore in the world. More careful investigation has failed to confirm some of the earlier estimates, and has led to the under-rating of the quantity of available Chinese iron ores. The series of Memoirs on the iron ores and iron industries of China, of which the first part by F. R. Tegengren has been issued by the Geological Survey of China,[1] will correct the wild statements that have been made on both sides. The first part deals mainly with the ores of the northern and eastern provinces, and is accompanied by 16 plates and a folio atlas including 39 maps. The first map, in which the names are conveniently given both in English and Chinese, shows the general distribution of the iron ores in eastern China. It does not mark those in far western China, where there are many primitive furnaces which smelt iron for their neighbourhood. Their supplies of ore are ample, but are too remote to be of service except locally at the present time.

The Chinese iron ores are of three main types. The first type comprises the pre-Cambrian bedded ores, including the banded quartzitic ironstones that are widely spread in western Australia, India, and South Africa. Of the pre-Cambrian ores the most interesting geologically are the stromatolitic ironstones, of which one of the best known representatives are the Wabana ores of Newfoundland. The author discusses their origin and attributes them to chemical precipitation; he discourages the view of their organic origin, though on grounds which are not convincing; and he recognises that they may indicate the existence of pre-Cambrian life. The second group includes the contact ores which have been formed beside intrusive masses of granodiorite along the lower Yangtze; they include some of the most important and extensive iron ore deposits in China. The third group includes the nodular ironstones of the Palæozoic rocks and they are found especially in north central China. They have been largely mined for the local smelters, and exaggerated estimates have been often formed of their quantity. The author concludes that in most cases the nodules are in beds too thin and too scattered to be of value for working under present conditions on an extensive scale.

The text is issued in both English and Chinese. The volume and the maps are well printed and edited; misprints, such as are probably inevitable when a work by a Swedish author is issued in English and printed in China, are commendably few, though the reversal of the headings of phosphorus and silica in the table on p. 38 gives at first a startling aspect to the analyses. The subsequent parts of this important memoir will include a summary of the distribution of the iron ores of the circum-Pacific region. J. W. G.

[1] "The Iron Ores and Iron Industry of China, including a summary of the iron situation of the Circum-Pacific Region." By F. R. Tegengren, Mem. Geol. Surv. China, Ser. A, No. 2, Pt. I., 1921–23, 180 pp., 16 pls. Accompanied by Atlas of 39 maps. Also Chinese Text.

University and Educational Intelligence.

APPLICATIONS are invited for two professorships in the Latvian University at Riga, namely, astronomy and theoretical mechanics, and geology and palæontology, the duties of which will date from January 1 next. The appointments will be for five years only, as at the end of that period the lectures will be delivered in the Latvian language. Applications for the posts should be sent to reach the Dean of the Mathematical-Natural Science Faculty of the University not later than November 1.

THE University of London Commerce Degree Bureau and Appointments Board has issued a useful little pamphlet entitled "Information as to Appointments and Careers for Graduates and Students." It has nineteen chapters on as many different classes of occupation — Teaching, Commerce and Industry, Civil Service, The Church, Law, Medicine, etc.—and concludes with a bibliography and "list of useful addresses." Copies are obtainable (price 1*s.*, post free; to members of the University of London, 6*d.*) from the Secretary of the Board, 46 Russell Square, London, W.C.1.

EDUCATION in relation to foundry work forms the subject of a useful report drawn up for the Board of Education by one of H.M. Inspectors, with the advice and assistance of Profs. C. H. Desch and C. A. Edwards. The unsatisfactory conditions affecting recruitment and training in the foundry trades have for some time engaged the attention of the British Cast Iron Research Association, the Non-Ferrous Metals Research Association, and other bodies. Unless these are improved, the general standard of foundries in Great Britain, even now lower than in the United States and several countries in Europe, is bound to deteriorate.

THE Indian Universities Conference held in Simla last May is the subject of an article in the June issue of the *Indian Review* by Mr. P. J. Hartog, Vice-Chancellor of the University of Dacca, formerly Academic Registrar of the University of London. One of the most important of the 44 resolutions passed by the conference was one proposing the establishment of an Advisory Board for Scientific Research, to comprise the heads of the scientific departments of the Government of India and a representative of science nominated by each of the Indian universities and by the Indian Institute of Science, Bangalore, with powers to co-opt representatives of other recognised institutes of science not affiliated to any university. There already exists a committee for medical research in India which has accomplished valuable work, showing that co-operation of this kind is practicable in India. Mr. Hartog infers, from the sympathetic reference made to the project by the Member for Education, that it may be realised at an early date. Commenting on the unanimous decision of the conference to request the Government to exempt scientific apparatus and chemicals for universities and other approved educational institutions from the payment of the 15 per cent. customs duty, Mr. Hartog remarks: "It seems absurd that while the charge on power-driven machinery is only two and a half per cent., that on brain-driven machinery is six times as great. The educational industry in India is a key industry, I might say the master-key industry, which perhaps needs more encouragement than any other."

THE purpose of education in schools is discussed at some length by the president of the Carnegie Foundation for the Advancement of Teaching in his annual report for 1922–23. The educational revolutio which has produced a great machine for the mas in place of a personal direct agency for the few ha brought with it certain dangers. The school bega as an agency for the development of the individua for the discipline of the mind and character, b methods involving intimate touch between teache and pupil. The machinery of organisation necessar for giving effect to the modern doctrine of universa compulsory education tends to obscure this purpos and the fundamental truth, stressed by the Arch bishop of York in his address on April 21 to th National Union of Teachers, that in the developmen of a human soul it is not the amount of informatio absorbed that counts, but the ability to think clearl and to bring out the right answers to the problem that present themselves in after life. For this th school is dependent on living contact between th growing mind of the child and the cultivated mind o a teacher whose primary qualifications must be inte lectual sincerity and moral simplicity and thorough ness. Paul Klapper, Dean of the College of Educa tion of the College of the City of New York, has con tributed to the March-April number of the *America Review* an article on "Educational Aims and Socia Progress," in which he similarly urges that educatio should "make power rather than information it final hope." This conception of the function of th school implies a demand for the critical examina tion and, when necessary, simplification of existin curricula and limitation of the size of classes.

THE London County Council has issued a Handboo of the lectures and classes for teachers which hav been arranged for the season 1924–1925. Thes lectures play an important part in connexion with th education of the Londoner. The successful teache must always remain a student, and these lectures ar designed to bring him into touch with the late developments in educational methods and to giv him opportunities of hearing leading authorities o their own subjects. Any person engaged in teachin in London is eligible for admission at fees whic average less than 1*s.* a lecture, while out-count teachers and others are admitted at fees 50 per cen higher. The lectures scheme is self-supporting, an last year the attendance was more than 16,000 Among the courses and lectures of interest to scientifi workers are the following: Prof. C. K. Tinkler (6 on fuels and ventilation; Prof. A. Morley Davies (6 on the geology and geography of the London basin Prof. E. J. Garwood (10), on the scenery of Switzerlan and its origin; Prof. E. H. Neville (6), on the element of the theory of curvature and curvilinear co-ordinates Mr. P. Abbott (10), on the teaching of arithmetic Prof. T. P. Nunn (9), on the teaching of mathematics trigonometry, and map-projection, and (5), on th teaching of physical science; Dr. C. W. Kimmin (3), on modern movements in education; Mr. W. H Winch (3), on the conditions of valid experiment i pedagogical methods; Dr. F. H. Hayward (5), o individual versus mass methods in education; Prof Cyril Burt (5), on mental and scholastic tests; Dr Charles Singer (10), on the history of science; Prof C. A. Carus-Wilson (5), on the teaching of science i secondary schools; Capt. P. P. Eckersley (4), o wireless telephony and broadcasting; Mr. Richar Kearton (5), on wild life round London; Maj. T. F Chipp (5), on Kew Gardens. Special single lecture are to be given by Sir Ronald Ross on malaria an mosquitoes (October 4), and by Prof. Karl Pearso on the relationship of mind and body (November 15) Copies of the Handbook can be obtained from th County Hall, Westminster Bridge, London, S.E.1.

Early Science at the Royal Society.

ugust 30, 1663. Mr. Colwall gave in an account ich he had received in a letter from the governor of Helena, concerning the tides, winds, springs, spouts, d weather there.—Mr. Colwall also mentioned, that . Thorowgood, a master of a ship, who had received tructions from the society for the East-Indies s returned, and had some account to give of what had done for the society in his voyage; which was desired to bring in.—Mr. Hooke produced explications of the new sounding instrument, and the vessel, that fetched water from the bottom the sea; and of the engine for determining the ce of gunpowder by weight. He was directed to aw the figures in great against the next meeting.

1666. Sir Theodore de Vaux produced some papers, ich were read, containing a relation of a furred e, made of the skin of the Tartarian boramez, pposed to be a plant animal; which robe was d in that paper to be kept in the library at ford, to which it was given by Sir Richard Lea, bassador in Russia in the reign of Queen Elizabeth. . Wren was desired to inform himself concerning is robe, and to view it on his return to Oxford.—r Robert Moray mentioned, that the King had been coursing of ant's eggs, and inquiring how they me to that bigness, which sometimes exceeded at of the insect itself.

eptember 2, 1663. The experiments of closing up gunpowder, *Aurum fulminans*, and water, in ree balls of steel severally, being again made; and at with gunpowder alone being fired and broken, it s debated, what might be the cause, that the npowder should fire, and not the gold powder; e latter being the stronger of the two?—Some nceived, that a sulphureous matter might exude t of the heated steel, and be communicated to the ld powder, whereby its fulminating virtue might deadned.—Others thought, that this powder ight fire within the ball (having left some air in it, cause not filled full with the powder) and the ise not be heard at a distance. Others were of inion, that the penning it in, and giving it but a w heat, might make it melt. It was ordered reupon, that the operator should bespeak two lls with cavities no bigger than a pea, to fill them ll severally with *Aurum fulminans* and gunpowder.

September 3, 1662. The president gave an account the society of his and the council's address to the ing in the name of the society, to return their mble thanks to his majesty for his favour in tablishing them into a corporation by his letter tent; with his majesty's answer of his peculiar teem of the society, and his readiness to give em all due encouragement: as likewise of their ldress of thanks to the lord chancellor [Clarendon] r his readiness to further that business; by whom ey were very favourably received, and assured, at it was his purpose to come himself to the society express his acknowledgments to them.

September 4, 1661. A proposition of Mr. Hobbes r finding two mean proportionals between two rait lines given, was delivered into the society by ir Paul Neile from the king, indorsed with his ajesty's own hand, and was ordered to be registered; s was afterwards the answer to the problem, by rd viscount Brouncker.—Mr. Wren was desired kewise to deliver a copy of his observations and ypothesis of Saturn to the amanuensis, to be trans-itted by Sir Kenelme Digby to Monsieur Frenich.—t was ordered that a collection of all quicksilver xperiments be made, examined, and brought in by Ir. Oldenburg.

Societies and Academies.

PARIS.

Academy of Sciences, July 28.—M. Guillaume Bigourdan in the chair.—Charles **Moureu**, Charles **Dufraisse**, and Marius **Badoche**: Auto-oxidation and antioxygen action. The catalytic properties of sulphur and its compounds: generalisation of the phenomenon. A detailed study of the action of sulphur and its compounds in the catalysis of auto-oxidation. Six oxidisable compounds were selected and a large number of inorganic and organic compounds of sulphur taken as catalysts. A summary of the more important results with benzaldehyde, acrolein, styrolene, turpentine, linseed oil, and sodium sulphite is given.—J. **Bordet**: The current theories of anaphylaxy. A critical review of the various theories which have been put forward to explain anaphylactic shock.—Henri **Jumelle**: Neodypsis and Chrysalidocarpus, palm trees of Madagascar.—F. **Gau**: The equation of the deformation of surfaces.—**Siegle** and **Cretin**: The elastic limit and resistance of annealed mild steels in the case of combined traction and torsion.—Th. **Vautier**: The propagation of explosive waves. An account of experiments on the transmission of sound waves in a tube one metre in diameter and several kilometres in length.—J. **Cayrel**: The influence of the pressure on the working of wireless detectors with solid contact. The pressure should be such that the mean resistance of the detector is of the same order of magnitude as the impedance of the circuit associated with the detector. If the impedance of the circuit is high the pressure should be small.—F. **Wolfers**: Interference by diffusion.—P. **Lebeau** and M. **Picon**: The action of heat and a vacuum on artificial graphite. In an apparatus described in an earlier paper the authors have utilised an electrically heated graphite tube. A preliminary study of the tube was necessary to determine the nature and amounts of the gases given up to a vacuum on heating. The present communication gives the results obtained.—Robert **Stumper**: The kinetic study of the decomposition of calcium bicarbonate in aqueous solution by heat.—Mlle. Jeanne **Liquier**: The anomalous rotatory dispersion of acid solutions of nicotine in relation with the concentration in hydrogen ions.—C. **Matignon** and C. **Faurholt**: A new synthesis of oxalic acid. At a temperature of about 470° C. and under a pressure of about 240 atmospheres, carbon monoxide reacts with potassium carbonate and some potassium oxalate is formed. The highest yield was 27 per cent. of potassium oxalate.—A. **Cornillot**: The constitution of phthalonic acid. Researches on its combinations with aniline. In the reactions studied, phthalonic acid reacts principally as an oxylactone, but a small proportion is clearly shown to react in the ketonic form.—Mme. Pauline **Ramart**: Molecular transpositions. The preparation and dehydration of 1 : 1 : 3-triphenyl-2 : 2-dimethyl-1-propanol. This compound on heating to 325° C. in the presence of infusorial earth gives isobutylbenzene and benzophenone; dehydrated with acetic anhydride and acetyl chloride, two isomeric hydrocarbons, $C_{23}H_{22}$, are produced.—E. **Asselberghs**: The existence of a fault in the French Ardennes.—J. **Savornin**: Geology of the Haut Guir and of the Moyenne Moulouya (Morocco).—L. **Gazaud**: Zones of silence. The zone of direct hearing, concentric with a focus of sound emission, is of very limited range; the zone which succeeds it is alternately one of hearing or of silence according to the presence or absence of high compact clouds.—Ph. **Schereschewsky** and Ph. **Wehrlé**: Perturbation currents and the polar front.—H. Colin

and A. Grandsire: Green leaves and chlorotic leaves: the ternary materials.—I. A. Christiansen, G. Hevesy and Sn. Lomholt: Researches by a radio-chemical method on the circulation of lead in the organism. There is an essential difference between the results obtained with bismuth and with lead. The quantities of lead accumulated in the liver and eliminated by the fæces are greater, at the expense of the amounts found in the kidneys and urine. With bismuth the latter organs play the principal part in elimination. —A. Fernbach and I. Stoleru: The influence of the reaction of the medium on the antiseptic properties of the hop. The antiseptic power of hops depends essentially on the hydrogen ion concentration of the culture medium.—E. Kayser and H. Delaval: Contribution to the study of wine yeasts.—Henri Stassano and A. Rollet: The carbonic acid removed from milk by the usual method of pasteurisation. The advantage of treatment in a closed circuit.—A. Demolon and Mlle. V. Dupont: The resistance of soils to acidification.—R. Argaud and D. Clermont: The glandular behaviour of the chordome.—Robert Ph. Dollfus: Polyxenia and progenesis of the metacercaria larva of *Pleurogenes medians*.

CAPE TOWN.

Royal Society of South Africa, July 16.—Dr. A. Ogg, president, in the chair.—D. J. Malan and D. E. Malan: The spermatogenesis of *Locustana pardalina* (Walker). (The Brown Trek Locust.) The chromosome numbers in more than 40 genera of locusts have been worked out, and in practically all cases it has been found that $2n = 23$ (male) and 24 (female). The few exceptions could all be accounted for by secondary linkage of non-homologous chromosomes.—H. O. Monnig: A new trichostrongylus from South African sheep. A description is given of *Trichostrongylus rugatus* n. sp. which occurs in the first 8 to 12 feet of the small intestine in South African sheep.—K. H. Barnard: The digestive canal of Isopod Crustaceans. The stomach (fore-gut) in a large number of Isopods of various families has been compared with that of Ligia, which may be taken as a basic type. A general agreement exists between the stomachs of omnivorous or herbivorous forms and those of parasitic forms, but with certain modifications due to the physiological differences in the mode of obtaining nourishment.—John Hewitt: Facts and theories on the distribution of scorpions in South Africa. The prevalence of primitive types in South Africa seems definitely against the probability of a South African origin for the families concerned. Assuming that the region of greatest differentiation of a group is its centre of dispersal, then we must look to Eurasia as the immediate source of scorpion fauna. But in most of the genera we find clear evidence of local evolution. These centres are different for different genera. Lines of gradational series of forms are explained as phylogenetic series ranged along former routes of migration, the simplest and oldest forms having migrated farthest from the centre of origin.—A. W. Veater: (1) Note on covariants and invariants of binary quantics. (2) Note on differential invariants of the group of homographic transformation of a plane and of certain sub-groups.

SYDNEY.

Royal Society of New South Wales, July 2.—Dr. C. Anderson, president, in the chair.—A. R. Penfold: The essential oil of *Backhousia sciadophora* (N.O. Myrtaceæ) F.v.M. The leaves and terminal branchlets yielded about 0·3 per cent. of a dark brown oil, which was found to contain about 80-85 per cent. *d-a*-pinene, the remainder being sesquiterpene, sesquiterpene alcohol, with small quantities of phenol and caprylic acid ester. The constants obtained were as follo Specific gravity, 15/15° C., 0·8799-8802; opt rotation, +33·7-34·2°; refractive index, 20° 1·4704 to 1·4717; solubility in 80 per cent. alcol insoluble in 10 volumes.—A. R. Penfold and Grant: The germicidal values of the pure constitue of Australian essential oils, together with those some essential oil isolates and synthetics. Rideal-Walker tests were carried out as described previous communications, the following results be obtained: Linalool (13), linalyl acetate (5·2 coumarin (4), vanillin (3·5), isoemethone (1 methyl eugenol ether (13·5), darwinol (13), darwi acetate (3), bornyl acetate (6), amyl salicylate benzyl alcohol (5·25), benzyl acetate (2), benzaldeh (9), anthranilic acid (aqueous solution, 2, et alcohol, 12), methyl anthranilate (6·5), anethole (1 anisaldehyde (7), cinnamic aldehyde (17), ment (synthetic) (20), menthol (natural) (20), valeria acid (2), ethyl valerianate (4·5), propyl valerian (8), butyl valerianate (10), isobutyl valerianate (8 amyl valerianate (5), menthyl valerianate (3), ben valerianate (6), phenyl ethyl valerianate (4), gera valerianate (2), rhodinyl valerianate (1), citrone valerianate (2).—A. R. Penfold and F. R. Morris Notes on *Eucalyptus piperita* and its essential o with special reference to their piperitone conte part i. The leaves and terminal branchlets yiel from 2 to 2·5 per cent. of pale yellow oil possess the following constants: Specific gravity, 15/15° 0·8924-0·9016; optical rotation, −52° to −64· refractive index, 20° C., 1·4805-1·4821; solubil in 70 per cent. alcohol, 1 in 5·3 to 9 volumes; pip tone contents, 42-48 per cent. These results considerably different from anything that has pre ously been published respecting this species, and authors have come to the conclusion that there two forms of this tree. It is the first time that composition of the oil, as obtained by Surgeon-Gene White in 1788 from trees of this species grow around Sydney (considered to be the type), has b revealed, the results published by Baker and Sm from material obtained outside of the Port Jack district being from another form of the species, n termed the mountain form or variety "A." T latter has been found to yield only 0·6 to 0·8 per ce of oil containing less than 10 per cent. piperitone.

Official Publications Received.

Supplement to the Journal of the Indian Mathematical Society, Vol Report of the Fourth Conference of the Indian Mathematical Soci held at Poona in April 1924. Pp. ii+32. (Madras: Indian Mathema Society.)

The North of Scotland College of Agriculture. Calendar, Ses 1924-1925. Pp. viii+164+xxiii. (Aberdeen.)

Diary of Societies.

THURSDAY, SEPTEMBER 4.

IRON AND STEEL INSTITUTE (at British Empire Exhibition), at 10.30 A. L. Aitchison and G. R. Woodvine: Changes of Volume of Steels du Heat Treatment.—C. Benedicks and V. Christiansen: Investigation the Herbert Pendulum Hardness Tester.—E. D. Campbell and G. Whitney: The Effect of Changes in Total Carbon and in the Condi of Carbides on the Specific Resistance and on some Magnetic Prope of Steel.—Prof. C. A. Edwards: Pickling: The Action of Acid Solut on Mild Steel, and the Diffusion of Hydrogen through the Met Dr. J. Newton Friend and W. E. Thorneycroft: Examination of from Konarak.—M. A. Grossman and E. C. Bain: The Nature of H Speed Steel.—A. Hultgren: Improvements in the Brinell Test Hardened Steel, including a New Method of producing Hard S Balls.—Dr. W. Rosenhain: Present Position of the Theories of Hardening of Steel.—F. C. Thompson and W. E. W. Millington: Effect of Free Surfaces on the Plastic Deformation of Certain Metal Ferrous Alloys Research:—Part I. Introductory, Dr. W. Rosenh Part II. Iron and Oxygen, F. S. Tritton and Dr. D. Hanson; Part III. Estimation of Oxygen in Pure Iron, T. E. Rooney. (Papers 6, 1, will be read and discussed.)

FRIDAY, SEPTEMBER 5.

IRON AND STEEL INSTITUTE (at British Empire Exhibition), at 10.30 A. (Papers 10, 8, 7, 2 from list given above will be read and discussed.)

NATURE

SATURDAY, SEPTEMBER 6, 1924.

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2862, VOL. 114]

Plant Quarantines.

THE raw material of vegetable origin produced in the British Empire for consumption as food or use in industry is of infinite variety and immense value. Rubber in Malaya, tea in India and Ceylon, cocoa in the Gold Coast, jute, cotton, rice, and oil-seeds in India, wheat and fruit in Canada and Australia, all represent interests of primary importance. It is natural, therefore, to find close attention paid to safeguarding the health of the plant world throughout the Dominions and Colonies, and in recent times there has grown up a system of barriers directed against the free circulation of living plants that might serve to introduce plant pests and diseases.

It has been recognised for some time that insect, fungous, and bacterial parasites of plants are readily transported from one part of the world to another with the living host-plants on which they feed, but not so readily in any other way. Many of these organisms are delicate and short-lived, requiring food and more or less congenial conditions to enable them to survive long journeys. On that account many have remained, probably for centuries, restricted to their proper habitat —the localities in which they are "indigenous." Increased facility of communication, and the opening up of large areas to the cultivation of crops that are often exotic, have greatly increased the chances of dissemination and harmful activity of these pests. Country after country has had its lesson in the invasions of insect and cryptogamic parasites of crops, and in many cases these have been traced to introductions from overseas similar to those to which attention was directed in England by the import of wart disease of potatoes and American gooseberry mildew.

To prevent these events, or at least to reduce their frequency, a series of plant quarantines is now in force in practically all parts of the Empire. It is, in many countries, easier for an alien to land than for a living plant to be secured entry from overseas. Permits to import have to be obtained by the importer, certificates of health and freedom from danger have to accompany the consignment, and an army of inspectors is occupied in granting these certificates and in re-inspecting the plants on arrival at the ports of entry.

Such restrictions are undoubtedly hampering to the export trade in nursery stock, and even, at times, to bulk trade in agricultural produce. In 1914 an abortive attempt was made to secure international agreement in establishing a common basis for facilitating commerce in living plants, through the International Phytopathological Convention of Rome. A further attempt is to be discussed shortly under the ægis of the International Institute of Agriculture in Rome.

Advantage was accordingly taken by the Ministry of Agriculture in Whitehall of the presence of a body of Dominion and Colonial botanists and plant pathologists, who were attending the Empire mycological and botanical conferences earlier in the month, to call a conference on July 17 to consider the whole matter. This conference was attended by a number of the scientific and administrative officials responsible for the application of plant quarantine measures in England and overseas, by many botanists and mycologists, and by representatives of the trade. The opportunity was taken for a frank discussion of the various interests affected by these measures, and of the scientific bases for their application.

There is no possibility of the producing countries withdrawing altogether their restrictions of plant imports. Nevertheless, there is a strong body of opinion that total prohibition may easily be carried too far, and that prohibitions should be as few as possible and carefully scrutinised from time to time, especially so as to avoid rejection of consignments because of a small percentage of infection with some pest already widespread in the importing country. It is felt that in some cases prohibitions are inspired by distrust of the methods of disease control in the exporting country and of the efficiency of the inspecting service which certifies to the health of export consignments. Such distrust can only be remedied, on one hand, by the establishment of really efficient methods of control and inspection, and on the other, by a closer contact between the services of the different countries, such as is secured by conferences of this nature. Without mutual confidence in the plant health services, increased facilities for trade in living plants are unlikely. There is a feeling that matters are improving in this respect, and it is hoped that ultimately some amelioration of the regulations now in force may result.

The common bases for international agreement are somewhat scanty at present. Only three were formulated at the meeting, namely, (1) that every country should have the right to impose prohibition of imports with the view of restricting the risk of introducing diseases, (2) that no country had a right to ask another country to accept its exports before it had established effective plant disease control within its own borders, and (3) that no country was entitled to make a similar request unless it maintained an efficient inspection service and proper arrangements for giving health certificates. Indeed, in a general way the chief result of the conference is a recognition of the fact that a country must set its house in order before it can secure such confidence in the health of its consignments as will facilitate their admission into other countries.

Exploration in Central Asia.

Records of the Survey of India. Vol. 17: *Memoi*
Maps of Chinese Turkistan and Kansu, from
Surveys made during Sir Aurel Stein's Explorati
1900–1, 1906–8, 1913–15. With Appendices
Major K. Mason and J. de Graaff Hunter.
xv+208+30 plates (+48 maps+12 charts, se
ate). (Dehra Dun: Trigonometrical Survey Of
1923.)

THIS memoir is a record of the geograph
surveys carried out by Sir Aurel Stein du
his explorations in Central Asia, and is accompa
by 47 maps of the mountainous and desert count
north of Tibet. Stein's journeys were primarily un
taken for archæological exploration, but he made
of his opportunities for geographical surveying.
geographical world owes a debt of gratitude to S
for his surveys of these inhospitable regions; his m
will for many years to come be the main source of
geographical knowledge of this portion of Asia.
maps have been printed in colours by the Survey
India, and the memoir furnishes information as to t
history; there is an appendix on Stein's triangulat
written by Major Mason, the triangulator of the Hi
Kush, and there is another appendix on Stein's heig
by Dr. Hunter, the mathematical adviser of
Survey.

The theatre of Stein's explorations has been
great mountain horse-shoe of Central Asia, known
the Tarim basin; the Tarim river collects the wat
from the glaciers surrounding the basin, and car
them eastwards until they are choked and lost in
desert of sand. The plains of the Tarim horse-s
have an easterly opening into the Gobi desert of Chi
on the south they are shut in by the snowy ranges
Tibet, on the west by the Kashgar range of the Pam
and on the north by the Tian-Shan mountains. Ins
the basin the sand is increasing owing to the d
integration of the surrounding mountains and to t
decrease of the surrounding glaciers.

Many parts of the earth have been discovered
geologists to have undergone a slow desiccation in t
course of ages. But Stein's surveys have shown th
the Tarim basin has suffered a rapid desiccation duri
the last 2000 years. The volume of water availa
for irrigation has decreased considerably within h
toric times; the relics recovered by Stein from t
sand-buried sites of ancient towns have shown th
the latter were abandoned about A.D. 400; a long li
of ruined boundary towers has been proved by
investigations to date from 200 B.C.

It was in 1898 that Stein first approached t
Trigonometrical Survey of India and asked for th

operation in his scheme for exploring the ancient
ts buried under the sands of Tarim. The Super-
ndent of the Survey was then Colonel Gore, and
n we now look back upon the brilliant successes
h have attended Stein's three expeditions, we cannot
t feel that this first meeting between the experienced
rtier surveyor and the young ambitious archæolo-
g has led to great results. At this meeting was
nded the alliance between the Trigonometrical
vey and Stein, an alliance that has lasted without a
ak for a quarter of a century.

tein has now carried out three expeditions. On
i first expedition (1900–1901) he was accompanied
Surveyor Ram Singh, and it was on this expedition
t he discovered the extensive ruins of Niya, which
e been abandoned to the sands since A.D. 300. It
on this expedition that the peak of Kongur
(25,146 feet) was definitely proved to be higher than
th famous Mustagh Ata (24,388 feet), which had
herto been believed to be the highest point of Asia
th of the Himalaya-Karakoram mountains. In
serving the clusters of peaks round Kongur, Surveyor
m Singh made a mistake that is not uncommon in
untain surveys; he mistook the identification of
ferent peaks as seen from different places, and from
observations the Trigonometrical Survey drew the
clusion that there were two Kongur peaks, both
her than 25,000 feet; this is now known to have
n incorrect; there is but one true Kongur peak
ight, 25,146 feet), and it is depicted in the second
otograph of the Memoir. It may be recalled that
lagintweit made the same mistake as Ram Singh,
en he was observing Mount Everest sixty years ago,
l that Schlagintweit's error of identification led to
name of Gaurisankar being wrongly applied to
Mount Everest, a geographical blunder that has been
fortunately perpetuated in the new *Times* Atlas.

On Stein's second expedition (1906–1908) Rai Sahib
m Singh again accompanied him, but his health
ve way under the hardships of the work and he was
eved in 1907 by Surveyor Lal Singh. On this
ond expedition Stein's feet were severely injured by
ist-bite, and he had to be carried back to Leh in
et, where the toes of his right foot were amputated.
the third expedition (1913–1915) Stein was again
companied by Surveyor Lal Singh, who had dis-
yed exceptional zeal and fitness for surveying under
ring conditions.

The discoveries by Sir Aurel Stein of the relics of a
nished population who had had to struggle for genera-
ns against the encroachments of sand took geo-
aphers by surprise. This people, whose rivers had
en choked and whose towns had been buried, were
nd by Stein to be of a higher civilisation than that
prehistoric race which was similarly driven from its homes in Europe by the advancing glaciers of the ice-age. The entombment of the Tarim towns was not sudden like that of Herculaneum and Pompeii, but it was as complete. Stein's descriptions [1] of the ancient sites have gained for him so high a reputation as an archæological explorer that his contributions to geography are apt to be overlooked, and for this reason the publication of the new Memoir will be welcomed.

[1] "Sand-buried Ruins of Khotan," 1904; "Ancient Khotan," 1907; "Ruins of Desert Cathay," 1912; "Serindia," 1921.

Mathematics of Relativity.

(1) *Introduction au calcul tensoriel et au calcul différentiel absolu.* Par Prof. G. Juvet. Pp. iv+101. (Paris: Albert Blanchard, 1922.) 12 francs.

(2) *From Determinant to Tensor.* By Dr. W. F. Sheppard. Pp. 127. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 8*s.* 6*d.* net.

(3) *Qüestions de Mecànica Clàssica i Relativista. Conferències donades el Gener de 1921.* Per Prof. T. Levi-Civita. (Publicacions de l'Institut de Ciències. Collecció de Cursos de Física i Matematica.) Pp. viii+151. (Barcelona: Institut d'Estudis Catalans, n.d.)

(4) *Les Axiomes de la mécanique (Examen critique): Note sur la propagation de la lumière.* Par Prof. Paul Painlévé. (Les Maîtres de la Pensée scientifique.) Pp. xvii+112. (Paris: Gauthier-Villars et Cie, 1922.) 3 francs.

(1) ONE of the most interesting features of Prof. Juvet's book on the calculus of tensors is the preface by Prof. Hadamard. In discussing the value of a book that deals with the pure mathematical theory of tensors, Prof. Hadamard has some hard things to say about the geometrical work of recent years. Henri Poincaré once said: "The physicist expects us to solve the problems that he sets us. But in setting us these problems he pays us in advance for the service we do him in solving them. The numbers and symbols of mathematics can form an infinite number of combinations. Of all this multitude how are we to choose those that are worthy of our attention? Should we be guided solely by caprice? . . . The study of physics prevents us from losing ourselves, or, more important still, prevents our moving constantly in a circle." Prof. Hadamard thinks that this danger of losing ourselves in a mist of symbolism or of moving continually in a circle of barren argument is, in fact, a characteristic of the innumerable researches of recent years, where "the classical ideas of Gauss, Ossian Bonnet, and Darboux reappear untiringly in all

possible orders, somewhat like the performers in a circus, or like the pieces of red, green, and blue paper that our children are made to put together at school in accordance with the methods of Froebel." Prof. Hadamard concludes: "Whatever view we may hold of the value of the new hypotheses of Einstein's theory, they give geometry a new rôle, and open out for her a new lease of life . . . full of infinite fertility. . . ."

For this reason and others, Prof. Hadamard welcomes M. Juvet's book, which is indeed a very good account of the main features of the pure mathematical aspects of the geometry of relativity. The theory of vectors is developed into the theory of linear transformations of vectors, and so into the theory of tensors, followed by the theory of quadratic forms and the tensors of generalised space. The illustrations of the meaning of the quantities g in the case of two- and three-dimensional space are very helpful. There is also a good account of the theory of parallelism according to Levi-Civita and Ricci.

(2) Dr. Sheppard's aim is similar to that of M. Juvet, and he carries it out with equal success. His point of view is distinctly different, due to the fact that he is interested in algebra rather than in geometry. The book consists of two parts—the first dealing with Determinants, the second with Sets. Basing himself on the possibility that a reader who wishes to study tensor methods may be insufficiently acquainted with the necessary determinant theory, Dr. Sheppard devotes five chapters to the subject. One may reasonably suppose that a reader unacquainted with determinants will scarcely be fired with ambitious schemes like the study of tensor theory, and that, in the rare event of this happening, his eagerness is quite unlikely to survive the shock of the author's eminently and severely logical presentation of the theory. We may, however, express the belief that Dr. Sheppard's real aim is to instruct the reader who does "know" determinants, and to lead him on to the algebraic point of view as applied to tensors in the second half of the book: at any rate all readers will find the chapters on determinants a useful and interesting repetition of theory that most students know rather vaguely. There are also one or two deviations from usual notation to add zest to the repetition.

From the theory of reciprocal determinants Dr. Sheppard introduces sets, double sets, and sets of higher ranks, and thus paves the way for the second part of the book, where the sets of arithmetical quantities become sets of variable quantities and finally tensors. He adopts the Einstein contracted notation for summation, but develops a notation calculated to avoid all misconception, one feature being that Einstein's contracted notation is used o with Greek suffixes.

As already remarked, the book is algebraic, opposed to Prof. Juvet's geometrical point of vi It is true that Dr. Sheppard gives a chapter on theory of tensors as applied to relativity; but e here the aspect is analytical only, and it would possible for a reader who did not know what the the of relativity is about to read the book without suspe ing that the subject is at bottom connected w geometrical concepts.

Mention must be made of Chapter xi., which de with the use of tensor calculus in the theory statistics, based upon recent papers by the author a by Prof. Eddington.

The book is one that all English readers of mathematics of relativity should study attentively.

(3) and (4) The books by Prof. Levi-Civita and P Painlévé are not primarily concerned with relativity such. The former is a set of four lectures delive by the distinguished Italian mathematician at Ba lona in January 1921, the subjects being the probl of three bodies, the propagation of waves in wa canals, parallelism and curvature in generalised spa and geometrical optics as applied to Einstein's theo The second book is a reprint of an essay by the fam French mathematician and statesman on the axiom classical mechanics, first published in 1909, as well an essay on the principles of mechanics and causal published in 1905 in the Bulletin de la Société Franç de Philosophie. An introduction and notes on r tivity theory have been added to the present reprin

If we associate these two books with the other bo of this joint notice, it is because the chief interest Prof. Levi-Civita's book must lie mainly in the maste exposition of the theory of parallelism—one of pioneering stages in the mathematics of generali relativity, while in the case of Prof. Painlévé's book reader can at once see that the republication of th two essays was dictated and motived by the relativ controversy.

The fundamental notion of the theory of paralleli is easily seen as follows. A developable surface c sists of a number of generators. Suppose that surface is developed into a plane: two generat which then become parallel are said to be parallel the generalised sense) when the surface is not develop and the directions of any two elements of curve the developable can be related in the same w Now we can fit a developable surface to any cu drawn on any given surface, the developable touch the surface at all points of the curve: hence we define parallelism between elements of curve on a surface. Developing the analytical conditions for su

allelism and extending to any number of dimen-
ds or variables, we are led to the general theory of
eilesics, and to the equations that play so important
art in defining the motion of a particle in Einsteinian
pace.

urning now to Prof. Painlévé's book, we have to
race the remark that his attitude towards relativity
one of caution, as shown both by the present
plication and by other contributions on the subject
lsewhere. "The theory of relativity is like very
ng wine, that inebriates brains which are in-
ufficiently accustomed to the rigorous discipline of
cience": for this reason the author advises particular
ttention to the fundamental axioms of the classical
ws of mechanics, in order that he who wishes to
tudy the modifications involved in relativity theory
may at least know what is being changed! Incident-
ally, Prof. Painlévé mentions one or two common errors
in the presentation of Einstein's theory. The first is
in the suggestion that the Lorentz transformation
applies when the relative velocity of two observers is
uniform: the transformation is really laid down only
for the case where each observer's motion is uniform
relative to the "absolute" space of Newton, or to the
system of fixed stars. Another error is the statement
that, according to the theory of relativity, the laws of
Nature are the same to all observers: of course, this
is only true in the sense that certain fundamental
differential equations are satisfied independently of the
particular frame of reference, its type or its motion.
It need scarcely be said that the errors here mentioned
are almost inevitable consequences of the attempts
made to put exact mathematical statements into vague
and "intelligible" language.

Prof. Painlévé insists on the existence of *privileged*
axes of reference in actual fact: but whereas in classical
mechanics we speak of these axes as absolutely fixed,
or as moving with uniform velocity relative to abso-
lutely fixed space, in relativity mechanics these axes
are at rest in, or move with uniform velocity relative
to the totality of bodies in the universe. Axes with
origin at the centre of mass of the solar system, and
in directions fixed relative to the *ensemble* of material
bodies in the universe, Prof. Painlévé calls *Copernican*
axes: axes moving uniformly relative to these are
called *Galilean*, as is the custom in most modern
writings on the mechanics of relativity.

The author, in fact, attributes a very important
place in the evolution of the fundamental axioms of
mechanics to the influence of Copernicus. Given forces
acting on a given system of bodies will make the system
assume a configuration which at any moment depends
on these forces, on the time, and on the conditions at
zero time—the *initial conditions*. Now what are these
initial conditions? Prof. Painlévé attributes to Coper-
nicus the germ of the principle of classical mechanics,
namely, that the initial conditions comprise both
position and *velocity* of each particle of the system.

Prof. Levi-Civita's book gives also a brief account of
the optical properties of Einsteinian gravitational fields
in a manner leading up to the discussion of the light
bending in the sun's field. The other two lectures
give excellent accounts of important modern topics.
The lecture on the problem of three bodies is on the
regularisation of the problem; *i.e.* putting the equations
of motion in such a form that singularities due to the
possible vanishing of the distance between two of the
particles are made to disappear, so that the variables
can be obtained, theoretically, as functions of the time
for all values real and finite. Sundmann's fundamental
investigations are explained, and the later work by the
author and others, leading to the regularisation of the
restricted problem of three bodies, and of the general
problem in three dimensions. The lecture on waves is
one of Prof. Levi-Civita's characteristic investigations
in two-dimensional hydrodynamics, reducing the prob-
lem of the propagation of waves of permanent type
to a functional equation, with Airy's formula for surface
waves and other approximate results as special cases.

Prof. Levi-Civita's book will be of interest to all
who wish to keep abreast of modern research in
problems of applied mathematics. Prof. Painlévé's
book should be read and re-read by all students and
teachers of mechanics. S. BRODETSKY.

Theories of Colour Vision.

An Introduction to the Study of Colour Vision. By Sir John Herbert Parsons. (Cambridge Psychological Library.) Second edition. Pp. x+323. (Cambridge: At the University Press, 1924.) 25*s.* net.

SINCE all knowledge comes to us primarily through the evidence of the senses, it is unavoidable that some of the greatest controversies which have occurred in the development of the sciences should have been centred around the *modus operandi* regulating the translation of the energy of a physical stimulus into the energy of thought. It is also not surprising that the fiercest and most prolonged of these battles, not yet concluded, should have originated in connexion with the sense of sight, whereby we come most widely and most directly into relation with our external surround-
ings. These struggles have resembled no merely local disputes. They are prolonged campaigns conducted on the common borderland of three great territories; and they cannot cease until "natural" delimitations are determined as the result of statesmanship rather than as the result of militant capacity.

K-I

In the case of the colour vision controversy, the stage now attained is, on the whole, that of statesmanship, which implies the recognition of essentiality. The chief essentiality was perceived early in the contest by some of the great leaders, but the compulsion behind their conclusions was not adequately perceived until their individual work had ceased. These great leaders, working on wide lines, sought to fix the physical law which dominates visual sensation and is true irrespective of the nature of the structural details which embody it. In such a case, time gradually, and almost imperceptibly, settles the matter.

The record of this process may be traced in Sir John Parsons's work. The dominating law referred to is that of trichromasy in colour mixture. The essentiality referred to is that of trichromasy in colour perception or sensation; but there is not yet universal recognition of the *pari passu* compulsion to trichromasy, *i.e.* a triple set of freedoms only, in the physiological and the psychological processes. Yet Fechner's law is universally recognised as, and is called, a psycho-physical law —the law which relates perception to, and expresses it in terms of, the physical stimuli with regard to the results of which triple freedom is proved. The point is not merely that freedoms cannot be added, while they may be removed, in any subsequent actions having that one-to-one correspondence to precedent actions which Fechner's law asserts to hold between sensation and stimulation under fixed conditions. It is rather that the triplicity is asserted with regard to the sensations themselves. There is no room left for an independent fourth fundamental sensation whether adopted on physiological or on psychological grounds, though it may, for some purposes of description, be convenient to adopt it and use it as if it were independent. A full description cannot then be attained until the connecting linkage is at least formally taken into account.

It is intensely satisfactory to find a physiologist of Sir J. H. Parsons's standing directly speaking (p. 313) of "the trichromatism of normal colour vision, which is a fact, and not a theory." He states quite frankly his recognition of difficulty in connexion with the trichromatic, or, as he calls it, the three components theory, on two points—peripheral vision and the so-called phenomena of induction. He says (p. 231) that "we must therefore accept the theory as explaining satisfactorily *either* the phenomena of after images *or* those of dichromatic vision, but not both." But this view results from a too circumscribed estimate of what the contents of the theory are. In this particular case he speaks of necessary modifications of the theory, while all that is necessary is its legitimate development to suit new facts. The possibilities of the theory are so great that the evidence of new facts is required to] limitations upon it, and that in the very matte which he speaks. At the top of the same page he s a dilemma arising from the Helmholtzian view o way in which stimulation by light of one colour incr sensitivity towards the complementary colour. the trouble only arises because Abney's, or sir fundamentals are used; and Helmholtz's work differential sensitivity shows that these cannot b absolute fundamentals. The dilemma is really existent.

Sir J. H. Parsons's volume has filled a great gap i scientific literature, and will be indispensable as a book or book of reference even after the appear of the American edition of Helmholtz's great w The treatment which it contains of the observati and the theoretical parts of the subject is very comp and the discussions of the various outstanding v are fair and full.

The new edition is gracefully dedicated to the mer of Abney and Watson, "worthy successors of Tho Young and James Clerk-Maxwell in this field of scien

W. PEDD

Chinese Pottery.

The Early Ceramic Wares of China. By A. L. He ington. Popular and abridged edition. Pp. 169 plates. (London: Ernest Benn, Ltd., 1924.) 12 net.

THIS abridged edition of Mr. Hethering excellent volume on the early pottery porcelain of the Chinese artist-craftsmen will be comed by all those students who were unable to chase the large and profusely illustrated volume which this has been condensed. The work of redu and compression has been so skilfully carried out there is little or no loss of matter that is absol relevant, and the work here presented will serve a admirable introduction to a complete knowledge o subject, and to the more important works to whic of us must turn for the completion of the story of Ch ceramics, in all its fascinating and masterly dev ments.

The immediate purpose and scope of this little cannot be better expressed than by an extract fro preface, where the author writes: "The chapte technique has been omitted, and so have the cha on miscellaneous factories and on marks and ins tions; the present object being to confine attentic the principal features displayed by the wares wit digressing into more difficult paths." As an exa of the care which has been taken to render this abri edition usefully complete, one may mention the li "The Dynastic Epochs of China from the Mythical

ndary Periods, before 2205 B.C." (a date which rsponds roughly with that of the XVIth Egyptian sty), down to the Yüan dynasty which held sway ina from A.D. 1280 to 1368.

one could wish for a more sprightly and enter-ing guide than Mr. Hetherington through the a's of the story he sets out to unravel. Wherever ble, the history is enlivened by some amusing o of the remote past or by some shrewd hint which help to untie a knot of ancient historic fact; yet, ays there is the underlying sensibility of the serious ent. As an example of this admirable faculty we ot do better than quote a passage where the author es with the evidence we now possess that the potters he T'ang dynasty (A.D. 618–907) knew how to ufacture true porcelain with felspathic glaze.

"The advance in technical knowledge denoted by the ufacture of true porcelain as an alternative to the of pottery bodies only, and by the use of high-fired athic glazes in substitution for the low-fired lead-ilate glazes, could not have been made very rapidly vi the scientific knowledge possessed in those days China. The process must have been evolved dually by experiments conducted by competent tsmen, no doubt, but by men without full apprecia-ic of the underlying scientific principles. One feels, herefore, that the Chinese must have known how to use th simpler types of glaze for a very considerable time bere the early part of the T'ang dynasty. The geeral tendency of further research into Chinese ce.mics is to antedate rather than to postdate various tyes of ware."

he reader will welcome the terse and definite ex-pdition of the technical and artistic qualities and cracteristics of the many types of pottery and pcelain that are passed in review; no less than the csideration and valuation of the different racial inuences, Chinese and other, that brought about the fil artistic results. The simplicity of means and directness of aim manifest in the earlier wares is duly al rightly appraised equally with the glorious yet sbtle colour-qualities of the Chün *yao* bowls and bulb-ps of the Sung dynasty. In addition, the author gives ainteresting summary of our present knowledge of the fmous Ting *yao*, with its well-marked varieties of ivory-wite or rice-white glaze. Of the purple and black Tig *yao*, once so coveted by Chinese connoisseurs, no specimens can be identified in modern collections in Erope or America, and we are principally dependent f our knowledge of them on the drawings and dscriptions in the album of a Chinese collector who lied in our Tudor times.

Naturally, there is a clear, though necessarily smmary, account of the renowned Céladon wares, which seem to have been more largely exported at the tne of their manufacture than any other variety of porcelain. In addition, the history of the Tz'ŭ Chow wares—made at what must be the oldest pottery-centre in the world that is still in active operation, for it dates back to the Sui dynasty (A.D. 589–618)—has its puzzles for the collector of to-day, for, as is well said, "It is extremely difficult to determine which specimens are of Sung origin and which of Ming or even later date."

In the final chapter we have an account of the Chien wares, which have only been recognised as a distinct class in what we may call recent times. The fascinating glazes which are usually associated with these wares and are distinguished on account of their markings as "hare's fur" or "partridge markings," are usually applied so thickly that in the majority of examples they form a dark pool in the inside and thick running lines with a terminal blot on the outside of the vessel to which they are applied. These special glazes appear to have been most extensively used in the decoration of small bowls which ritual use long ago prescribed for the "tea ceremonial" or tea contests. The Chinese have always been inveterate gamblers, and in this particular "gamble" the idea was to pit the cup of this type owned by one connoisseur against that owned by another to decide which would retain moisture longest. As Mr. Hetherington says, "The game seems a curious one to Western minds, but, after all, roulette has no more claim as a sensible method of gambling." The tea ceremonial was introduced into Corea and Japan, and with it the bowls and other apparatus of the game. The Japanese have made many varieties of these bowls, some of which are difficult to distinguish from Chinese specimens; though any one who collects with an eye to beauty alone may be delighted to treasure a Japanese specimen for its æsthetic worth.

A word must be added in praise of the illustrations, for though there is only one coloured plate (an extremely beautiful one), the half-tone illustrations convey an excellent impression of the objects they represent, and will greatly aid the student in the identification of specimens.

WILLIAM BURTON.

Diseases of Wild Animals in Captivity.

Disease in Captive Wild Mammals and Birds: Incidence, Description, Comparison. By Dr. Herbert Fox. Pp. vii+665+91 plates. (Philadelphia, London and Chicago: J. B. Lippincott Co., 1923.) 60*s.* net.

ALTHOUGH it is the custom in most zoological gardens to keep a record of all post-mortem examinations, this is the first time an attempt has been made to correlate the results and place them in a compact form before the medical and veterinary professions.

Dr. Fox has held the post of pathologist at the Philadelphia Gardens for the past twenty years, and during that time has had the opportunity of making post-mortem examinations on 1860 mammals and 3505 birds. In addition to this he has also studied the living animals, and has been able to apply his pathological findings to the diagnosis, treatment, and prophylaxis of disease in general. The result of his work has been of extreme practical value in the management of the Philadelphia Gardens; epidemics have been arrested by scientific disinfection, and certain diseases, such as spiropteriasis in parrots and tuberculosis in monkeys, have been entirely eliminated. In order to prevent the introduction of tuberculosis, every new arrival before being placed in the collection is subjected to the tuberculin test, and the variations of temperature during the ensuing forty-eight hours are recorded. In healthy animals there is no reaction; in tuberculous animals there is usually a definite rise in the first twelve hours. No animal showing a positive reaction is placed on exhibit.

Among other communicable diseases investigated, the "jaw disease" of kangaroos has been made the subject of special research. The causative organism of this disease was found to be one of the Mycobacteriaceæ, which was cultured successfully and a vaccine prepared. It was found to be new to science, and has been named *Nocardia macropodidarum*. From experiments upon laboratory animals with cultures of *N. macropodidarum*, it would appear that the disease is transmitted with difficulty. As it is always found associated with a small Gram-negative bacillus, it is possible that the bacillus is a necessary factor in the production of the disease.

The section on the incidence and significance of animal parasites, by Dr. F. D. Weidman, emphasises the value of zoological gardens in general as a field for research on this subject. Tables showing the pathogenicity and frequency in the various orders are given, and various methods of treatment and prophylaxis are suggested.

The tables giving the relation of diet to disease show that birds and mammals which live on a mixed diet of plant and animal tissue are less liable to disease of the alimentary tract than those which are entirely carnivorous or herbivorous. The percentage of thyroid disease and rickets was highest among the Carnivora.

Neoplasms, both benign and malignant, are treated at some length, and valuable tables are given, showing the type of growth, organ of origin, relation to sex, duration of captivity, metastases, and order of animal affected. Neoplasms were found to be commonest among the Rodentia, Marsupialia, and Carnivora, and rare among the Primates. The main organs affe were uterus, liver, thyroid, and mammary glands.

The book is well illustrated with photograph microscopical and macroscopical specimens of pa logical changes, in addition to numerous intere and valuable statistical tables dealing with th cidence of disease.

In the foreword, Dr. C. B. Penrose, the presi of the Philadelphia Zoological Society, makes s general remarks on some of the problems which in relation to the keeping of animals in captivity, the various mental perversions which are com among them, some of which are akin to prison psych in man. Diseases of the central nervous system special senses are dealt with in a special sectio are the diseases of all the other organs of the body

There is no doubt that this work, which is essent a pioneer effort, should be read by every compara and human pathologist. By those who are conce in the management of living animals in captivit will be found to be a mine of valuable information

Our Bookshelf.

(1) *Physics.* Vol. I.: *Mechanics, Heat and Engines.* By W. J. R. Calvert. (Science for Series.) Pp. x+260. (London: John Mur 1924.) 3*s.* 6*d.*

(2) *A Text-Book of Physics: including a Collectio Examples and Questions.* By Dr. W. Wat Eighth edition, revised by Dr. Herbert Moss. xx+976. (London: Longmans, Green and 1923.) 16*s.* net.

(3) *Thermodynamique: Énergétique: Théorie cinét des gaz* (*Cours professé à la Sorbonne*). Par I A. Leduc. Pp. iii+333. (Paris: Gaston D 1924.) 25 francs.

ACCORDING to Dr. George Saintsbury, "A review is a thing addressed to the general body of educ people, telling them whether it is or is not worth t while to make further acquaintance with such-and-s a document purporting to bear their address." I of the three books included in the present notice ha own merits, but each is addressed to a special clas reader.

(1) The book by Mr. Calvert, who has been a sci master at Harrow since 1909, forms the first vol on physics in the "Science for All" Series. I intended for pupils up to the age of, say, sixteen, are taking a course of science as part of their gen education. For such students the book is a n admirable one, the interest, both from the scientific the literary point of view, being skilfully sustai throughout. The ideas of work and energy form main theme, applications being made to the subj of hydrostatics, statics and dynamics, and heat. I preface of unusual interest Mr. Calvert discusses principles underlying the teaching of science in earlier stages of a general education. Such teach should give the pupil some idea of the aims of scie

the kind of problems with which it deals; a ledge of some of the broad fundamental principles; ome insight into scientific method.

Dr. Watson's "Text-Book of Physics," intended nore advanced students, is too well known to re more than the briefest notice. In the revised ion considerable additions have been made to ir the work into line with recent progress, especially te subject of electricity.

Prof. Leduc reproduces in this volume a course out thirty advanced lectures on heat delivered at e Sorbonne. He remarks that amongst his hearers te physicists are in the minority; nevertheless, ightly considers it desirable to consider his subject o the point of view of research, discussing the methods d results of recent investigations, including those as himself undertaken. Stress is laid on the cy of the numerical results, and one of the luable features of the work is the information (not ys easily accessible to the student), which is supplied the quantitative values arrived at in the most t determinations of thermal constants. The book ded roughly into four parts. The first deals with ral questions connected with thermometry, calori- y, and equations of state. The second and third are devoted to the general principles and applica- of thermodynamics respectively, whilst the very fourth part deals with the kinetic theory of gases. I a few cases the historical references are not plete or accurate. It is probably useless to protest gainst the constant use of "la loi de Mariotte," but we cannot have Boyle's law, we would enter a plea some mention of Joule's law as to the additive re of the specific heat of compounds. Again, 'Expérience classique de Tyndall" (p. 204), in which a ded wire cuts through a block of ice, is really due Lord Kelvin's nephew, Dr. J. T. Bottomley, as is ted in "Heat a Mode of Motion," p. 150 (1887). In pite of some minor defects the book is an excellent on and an English translation might well appeal to a large number of students. H. S. A.

An Elementary Treatise on Frequency Curves and their Application in the Analysis of Death Curves and Life Tables. By Arne Fisher. Translated from the Danish by E. A. Vigfusson. American edition. Pp. xvi+244. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1922.) 20*s.* net.

THIS book under notice is divided into two parts; the first gives an account of the Gram-Charlier curves and curve fitting taken, in places verbatim, from the author's "Theory of Probability" and the second part deals with a method of estimating rates of mortality from statistics of the numbers of deaths from various causes at each age. The object in finding a method which will enable the statistician to dispense with censuses, or exposed to risk, when estimating mortality is that in some cases only the deaths are known and in others the trouble and expense of obtaining a census, or exposed, are considerable. The author's method is to choose a system of frequency curves based on the hypothesis that the distribution of deaths according to age from certain groups of diseases can be made to conform to those assumed curves; proportional death rates are calculated for each age (or groups of ages) according to the grouped causes of death. From these figures, by a lengthy arithmetical process, the number dying in a stationary population is reached, and this leads to the rates of mortality. The method is interesting and in some cases it gives results which are in close agreement with those obtained by the usual methods, but, in other cases, the examples given seem to imply that there may be considerable errors in the result, although in these cases a modification of the groupings of deaths might lead to improvement. It would appear from *a priori* considerations that, in some circumstances, it must be impossible to obtain a satisfactory result from deaths alone (compare, for example, two experiences having rates of mortality such that the rates by one are equal to r times the rates of the other at all ages).

The book has many defects; some of them are no doubt due, as is suggested by the author in his preface, to the original Danish MS. of the second part of the book having been translated by an Icelander and to the composition and proof reading having been done by a Copenhagen firm; but the explanation affords little comfort to the troubled reader. Possibly the international nature of its origin accounts for the fact that the book, which is dated 1922, has only recently reached us. Another point open to criticism is the omission of a clear explanation at the beginning of the second part of the theory and assumptions on which the author intends to base his construction of mortality tables, so that a reader has more difficulty than is necessary. We think that the author would have been well advised if he had set out some, at any rate, of the difficulties and criticisms that would naturally occur to his readers and how he would propose to answer them.

The idea and the method are interesting; but the evidence in favour is not conclusive and we are afraid that the remark in Prof. Raymond Pearl's introduction that "it may fairly be regarded as *fundamentally* the most significant advance in actuarial theory since Halley" is an unfortunate over-statement.

Smithsonian Institution. United States National Museum: Bulletin 82. A Monograph of the existing Crinoids. By Austin H. Clark. Vol. 1: The Comatulids. Part 2. Pp. xxv+795+57 plates. (Washington: Government Printing Office, 1921.)

RARELY can there have been produced a work so thoroughly deserving the title of Monograph as this vast production of Dr. Austin Hobart Clark's. The first part, of 387 pages, issued in 1915, dealt with some general principles and began the account of the anatomy; it is unfortunate that the pre-occupations of war prevented it from receiving adequate notice. This second part, continuing the description of the comatulids or feather-stars, completes the details of their anatomy, family by family and species by species. There follows a summary of the development, again with reference to every species in which any larval stage is known. An interesting chapter is that on the various habitats of the littoral crinoids. There follow notes on the habits of Antedon, and then a long, well-documented list of parasites and commensals. Next are brought together the scattered observations, experimental and other, made on the tropisms and relations to environment of numerous comatulids.

The chapter on the colour of crinoids includes the stalked and sessile forms as well as the unstalked. The part ends with a section on the economic value of the recent crinoids; this is confined to their sale as curios, for, we are told, they serve no useful purpose; they are not even eaten by any animal that serves as human food. In this respect it is probable that the recent crinoids have acquired a securer footing than some of their large-bodied ancestors.

These two large books, though they contain only "introductory matter" to the systematic descriptions, already furnish a corpus of nearly every observation ever made on these beautiful creatures, and reference is facilitated by full tables of contents and indexes. Although a great deal of the work is based on Dr. Clark's own observations, especially concerning the skeletal and muscular anatomy, it does not profess to give new facts or original theories. That in no way lessens its great value to the worker, who will also find his wants attended to by various keys and by comparative diagrams. He will be grateful to Dr. Clark and will marvel at the energy and perseverance that have brought him so far along a laborious road.

F. A. B.

The Subject Index to Periodicals, 1917–1919. Issued by the Library Association. L: List of Periodicals Indexed and Author Index. Pp. ix+103. (London: Grafton and Co., 1924.) 21*s.* net.

THE alphabetical index of names of authors of articles included in the various Subject Indexes to Periodicals issued by the Library Association for the period 1917–1919 has now been published. The index contains more than 20,000 names of authors, with the sections of the Index and the headings under which the titles of their papers are registered. It is estimated that, on an average, each author has published two papers, so that the total number of papers indexed for 1917–19 will be about 40,000. Those who possess the valuable Subject Indexes already published will be able through this author index to find a paper when they have forgotten its title although they remember the author's name. The abbreviations for 477 periodicals used in preparing the indexes for 1917–19 are also given.

The headquarters of the "Subject Index to Periodicals" were transferred to the National Library of Wales, Aberystwyth, in January 1921. The access to periodicals in this Library has been of great assistance to the editors in preparing the indexes. The editors record the voluntary help they have had from some forty-eight libraries in Great Britain and from a number of private contributors. While expressing its grateful thanks to all who have helped in the undertaking since its beginning in 1915, the Library Association makes a strong appeal for assistance to those librarians who have hitherto held aloof from active co-operation in the work.

It is obvious that the value of the Index depends upon its completeness; although up to the present time some 575 periodicals have been examined, some of the libraries that have not yet taken part in the work may very well have on their shelves other periodicals containing relevant matter. We would urge any such libraries to consider whether they cannot arrange to assist in the future.

Laboratory Experiments in Chemistry: to accom Black and Conant's "Practical Chemistry." N. Henry Black. Pp. x+167. (New York: Macmillan Co.; London: Macmillan and Co., 1923.) 5*s.* net.

THE author of this small work can be congratul upon having written a really practical text-book w is much superior to most of those now used in G Britain. Its chief feature is absolute clarity of pre ation; no pupil should go wrong if he follows faith the directions given, and if he tries to answer numerous questions interpolated throughout the he will exercise his intelligence as well as his fingers his capacity for obeying instructions. Those prefer the strictly heuristic method of teaching probably not regard with favour a book of this k but they would find it very useful if—as is usually case—they are expected to cover a lot of ground a large class in a limited time. Other valuable feat are the optional work given after each experim and, near the end of the course, some elemen lessons in applied chemistry. The present writer given some of these experiments to his pupils and testify to their value, not only in imparting knowl but also in stimulating interest. Some minor poin criticism will doubtless suggest themselves to e teacher, but these are negligible in comparison the excellence of the work as a whole. Uncons humour, too, is not often to be found in a school book, but if the reader will refer to the second sent on page 1 of this book and then glance at the illu tions on the frontispiece opposite, he will learn the homely test-tube, beaker, crucible, etc., are an the "less familiar" pieces of apparatus. We wo what are the more familiar pieces of apparatu American schools?

Principles of Electric Motors and Control. By Go Fox. Pp. xiv+499. (London: McGraw-Hill lishing Co., Ltd., 1924.) 17*s.* 6*d.* net.

MOST books describing electric motors and contro are written mainly from the point of view of the signer, that is, from the point of view of the m facturer. The number of operating engineers, how is much larger than the number of designers, and fa application, as the author points out, can nullify design. This book is intended for students and those interested in the selection, application, purch and sale of electric motors and controllers. The cussions are simple and practical and will be e understood by the engineer. Although many gr are given, vector diagrams and higher mathem have been rigorously excluded. The control diagr all conform to standard American practice, but practice in Great Britain is much the same. A full bibliography is given.

The book will be found helpful both to the prac and theoretical electrical engineer. The latter will in it diagrams which illustrate excellently prac applications of known theoretical principles with w he is familiar. For example, a clear diagram is g of the principal connexions for converting from system of supply to another of different frequenc constant power.

Letters to the Editor.

T Editor does not hold himself responsible for inions expressed by his correspondents. Neither n he undertake to return, nor to correspond with e writers of, rejected manuscripts intended for is or any other part of NATURE. *No notice is ken of anonymous communications.*]

himæras Dire: Transplantation of Heads of Insects.

ITH some astonishment I notice my friend, W. T. Calman, agreeing with the German authors as Blunck and Walter Speyer in his letter to URE of July 5, p. 11, entitled "Chimæras Dire," vich is written with much sarcastic humour, but ite knowledge of the subject. The title itself is nleading. Walter Finkler has never claimed to e produced Chimæras in adult insects, a term ifying in biology "simultaneous development of ts compounded from tissues of different species o races)"; he has merely studied the possibility of relantation of heads and described the results treof. He has neither written that "The head of a bivorous water-beetle persuaded a carnivorous dy to be content with, and seemingly to digest, a vetable diet," nor that "a Dytiscus strove to derate the colourings of its wing-cases to suit the ser tastes of its new Hydrophilus brain." The ny part of Finkler's work referring to nurture (*Archiv f. mikrosk. Anatomie u. Entwickl.mechanik*, xix., 1923, p. 113) alludes to the passage of coloured ae through the re-established connexion between th cut ends of the œsophagus in *homoplastic* experiments on the replantation of Hydrophilus-heads, while the assumption of a darker hue after heteroplastic replantation of a Hydrophilus-head to a Dytiscus-body refers to the yellow crossbars of the thorax in the swimming beetle (pp. 127-128), a result Finkler ascribes to the influence of eyesight, but that can perhaps be more readily explained on the assumption of tyrosinase diffusing from the head to the thorax.

Dr. Calman's sentence, "a male head led a female ly into unwonted perversities," will, I am afraid, do produce a wrong impression of Finkler's observations. Finkler's xenoplastic experiments on the exchange of heads between a male and a female Hydrophilus were conducted to see if the reproductive glands have any influence on the sexual instinct as displayed by the head in the antennal play of the male (and the several reflexes of the legs inspired by the œsophageal ganglions of the intact imago). The result was that no such influence could be detected (p. 124). The male head kept its usual reaction towards the female, and the female head did not acquire this character when transplanted to a body of opposite sex, quite in agreement with the many experiments on other insects, where removal or even heterological exchange of the reproductive glands in larvæ always failed to display any change in the secondary sexual characters of the imago.

As to the knowledge of Drs. Blunck and Speyer, already known by a long series of anatomical and biological researches on the very water-beetles that were among the chief of Finkler's *corpora vilia*," of the physiology of these insects, I have just stated an example of it: they have maintained that a Hydrophilus with Dytiscus-head could never live in water, because the former needs its feelers for respiration. Any one can easily convince himself of the fallacy of this belief, dating from an unlucky fabulation of Kitzsch (1811!) and repeated, it is true, in all treatises on the physiology of these beetles since his time. It is only necessary to amputate both antennæ of some Hydrophilus and keep the beetles as usual in water with some algæ. No inconvenience will befall them on account of this loss. I have a paper in the press on this subject for the *Zoologischen Anzeiger* which is to appear shortly, discussing the various criticisms of Finkler's experiments by several authors in Germany. I need not, therefore, go into further details now.

I should, however, like to add that Finkler has not "ignored requests to produce his chimæras, alive or dead, for investigation by others." His transplantations were produced alive at the meeting of the zoological section of the Zool. Bot. Society of Vienna on November 11, 1921, for general inspection, and some dead specimens were handed on to Dr. Boulenger (has not Dr. Calman had the opportunity of seeing these himself as an "exhibit at a Royal Society soirée"?); the total preparations of the beetles, of which Finkler's Plate IV. gives but a poor impression, are in our Museum and hundreds have seen them. Wit is appropriate "in the pages of *Punch*"—but in the pages of NATURE we should try to keep to strict truth.

As to Mr. J. T. Cunningham's recent note (NATURE, July 26, p. 124) on "Transplantation of Heads of Insects," I am puzzled if it is meant as a joke or is the author really used to making his experiments on *five* individuals? (By the way, I am sure he cannot have read Finkler's paper, or he would have known that Finkler has attempted the transplantation of the *head alone* in the meal-worms without success.)

HANS PRZIBRAM.

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Vienna II. Prater.

Radial Velocities and the Curvature of Space-time.

THE question of the reduction of the Doppler effect from the earth to the sun, or conversely, raised by Prof. Eddington in NATURE for May 24, is completely settled in my letter of May 10, which was published in NATURE for June 7, p. 818.

In his letter, however, Prof. Eddington mentions another point, the possible occurrence of an "imaginary star constant v_0" in

$$D^2 = r^2/R^2 + v_0^2/c^2, \quad . \quad . \quad . \quad (1a)$$

which requires an explanation.

The actual position is this. With some R-value, derived from previous material, a new object of estimated distance r may show an effect $|D|$ smaller than r/R. Then (1a) calls for a negative v_0^2 or an imaginary v_0. What is the meaning of such a value? Simply, that the orbit *does not pass* through O, the sun, but ends at some perihelion distance $r_0 = R\sigma_0$, where the motion is reversed. Such radial motions are possible in de Sitter's world. Even then the analytical form (1a) may be retained, provided we remember that v_0^2/c^2 is to be replaced by $-\sigma_0^2$. In fact, by the equation of motion (NATURE, March 8)

$$\frac{R}{c}\frac{d\sigma}{dt} = \pm \cos\sigma\sqrt{1 - \cos^2\sigma/k^2} = \pm\frac{v}{c},$$

or by the original meaning of the constant, $k = \cos^2\sigma c dt/ds$, we have

$$k = \cos^2\sigma/\sqrt{\cos^2\sigma - \dot{v}^2/c^2} = \text{const.}$$

If the star passes through the sun, $v = v_0$ for $\sigma = 0$, and $k = (1 - v_0^2/c^2)^{-\frac{1}{2}}$, and the formula

$$D = k[1 \pm \sqrt{1 - \cos^2\sigma/k^2}] - 1 \quad . \quad . \quad (1)$$

reduces approximately to (1a). But if it does not

pass through the sun, we have $v=0$ for $r=r_0$, so that $k=\cos\sigma_0$, and (1) becomes, for small σ_0, σ,

$$D^2=\sigma^2-{\sigma_0}^2=\frac{1}{R^2}(r^2-{r_0}^2). \quad . \quad . \quad (1b)$$

If the object, no matter how distant, just passes through its "perihelion" or nearly so, we have a nil-effect or a small effect. Such cases may be rare (as *e.g.* that of N.G.C. 6626), but are possible and well provided for by the general formula (1). This removes every difficulty. At the same time we see that, in a correlation graph, the observed points r, $|D|$ need not lie all above a certain line, but may as well fall below it. They should only show a tendency of crowding along it, on either side, gathering pre-eminently, but not exclusively, in the first and the third quadrants (NATURE, June 7, p. 819, Fig. 1). Such a tendency is shown, by the points thus far available, markedly enough. These relations and formula (1*b*), a supplement to (1*a*), are discussed in my second *Phil. Mag.* paper now in the press. There also the desirable extension of the formula from radial to *any* inertial motions is given. If $r_0=R\sigma_0$ and $v_0=c\beta_0$ be the distance at and the velocity of passage through the perihelion, the result is, rigorously,

$$D=\frac{\cos^2\sigma/k}{1\mp\sqrt{1-\frac{\cos^2\sigma}{k^2}\left(1+\frac{p^2}{R^2\sin^2\sigma}\right)}}-1, \quad (2)$$

where

$$k=\cos^2\sigma_0/\sqrt{\cos^2\sigma_0-\beta_0^2}, \quad p=R\beta_0\sin\sigma_0/\sqrt{\cos^2\sigma_0-\beta_0^2},$$

and approximately, to all purposes,

$$D^2=\left(1-\frac{{r_0}^2}{r^2}\right)(\sigma^2+\beta_0^2), \quad . \quad . \quad (2a)$$

of which (1*a*), (1*b*) are but obvious special cases. The statistical formula, (2) (NATURE, June 7, p. 818), now becomes $R^2=\frac{2}{3}({r_1}^2-{r_2}^2):(D_1^2-D_2^2)$, and, when applied to all thirteen objects there tabulated, gives $R=7{\cdot}2\times10^{12}$ astr. units. Details are given in the last-mentioned paper. LUDWIK SILBERSTEIN.

Rochester, N.Y., July 5.

Growth-rings of Herring Scales.

WHILE engaged upon work on herring scales at the Ministry of Fisheries' Laboratory at Lowestoft in 1922 and 1923, I made several discoveries regarding the so-called "winter rings," and the comparative growth-rates of scale and fish. These discoveries appeared to me to be of sufficient importance to be brought forward for discussion at a meeting of the Herring Committee of the International Council held at Edinburgh in June 1923, at which I offered a theory of age-determination alternative to the Norwegian theory.

At a later meeting held at Christiania in June 1923, the Herring Committee rejected my theory and adopted the Norwegian theory as a working hypothesis. To this resolution I was a subscriber with some misgivings. In the light of further research, however, I am compelled to revert to my former position, and, while, in accordance with the resolution of the Herring Committee, the Norwegian theory is accepted by the Ministry of Fisheries as a working hypothesis, it has been thought desirable that I should be given an opportunity to state publicly the main facts on which my theory is based, since these have not yet been published. They are as follows:

(1) While in the case of young herrings the number of "winter rings" is the same on all normally developed scales, in the case of older fish there is considerable variation in their number. The greatest numbers appear on the large scales from the forepart of the body (position A), which are used by the Norwegians for age-estimation, while the smaller numbers of clear and easily-read rings appear on scales from near the edge of the dark dorsal pigment and below the posterior end of the dorsal fin (position B). Photos, Fig. 1 and Fig. 2, are of scales from two English fish of 27 cm. in length, landed at Lowestoft. Fig. 1 is from position A and Fig. 2 from position B.

(2) The proportionate growth-rates of scale and fish are similar on scales from regions A and B in the case of small herrings, but increasingly dissimilar as larger and larger fish are taken. Thus, in large fish of which the scales from position A are very ringy (usually known as "old" fish), either the ringy scales have grown disproportionately fast or the scales from position B disproportionately slow in the later life of the fish. That the differences

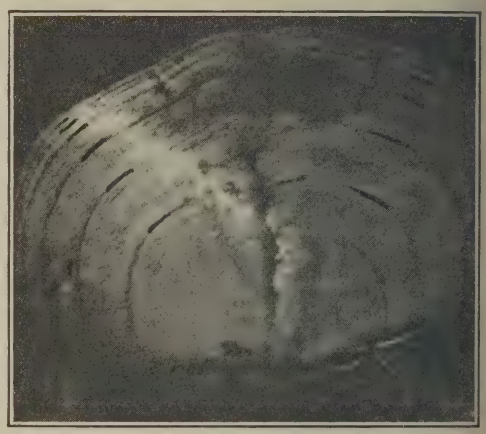


FIG. 1.—Showing six rings traceable all round the striated portion.

in the "calculated growth" are significant is obvious from the following examples:

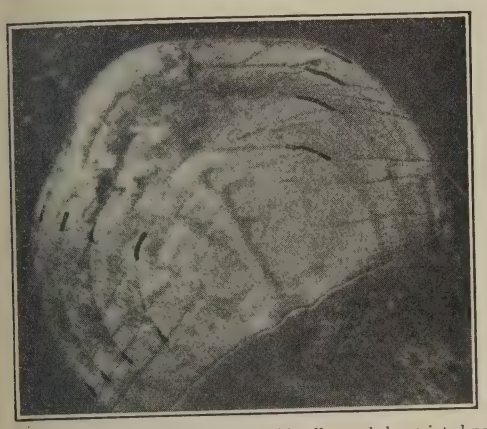
			Calculated Growth. Scale from Position (A).	(B).
(1) Shields fish .	37 cm.	1st year	10·5	12·6
		2nd ,,	20·3	23·6
		3rd ,,	27·2	30·4
(2) Norwegian .	34 cm.	1st ,,	8·0	9·8
		2nd ,,	15·1	16·9
		3rd ,,	22·6	25·5
(3) Norwegian .	34 cm.	1st ,,	6·7	8
		2nd ,,	12·1	14·1
		3rd ,,	21·3	23·8
(4) Norwegian .	34 cm.	1st ,,	6·4	8·8
		2nd ,,	11·0	13·6
		3rd ,,	13·8	17·1

This discrepancy in calculated growth is due to difference of growth-rate taking place mainly in the later part of the herring's life, as may be seen by assuming any length, say 15 cm., for the length of the fish (say No. 4) at the formation of the 3rd ring and calculating the two first years' growths from the two scales, giving

	Scale A.	Scale B.
1st year . .	7·1	7·7
2nd ,, . .	12·0	12·0

This is very significant, considered in relation to the so-called "phenomenon of decrease of calculated growth-rate with age," which is ascribed by the Norwegians to the influence of migration, the larger fish of each year-class joining any shoal of large fish first.

) The groupings of rings on the outer part of h scale of large herrings. In a large number of as of ringy scales there is a tendency for the inter rings" to get closer and closer as we go rn the centre of the scale, until they become very rvded at a certain point; after which they widen n again get closer and closer, and again become rvded. Fig. 3 exemplifies this phenomenon. If h rings are read in groups, instead of singly, an



ig. 2.—Showing only four rings traceable all round the striated portion.

eimate of age is arrived at, differing widely from tat based on reading of single rings—in the present se 5 years instead of at least 14 years, the inner oup under a high power being seen to consist of aout 5 rings, and the outer of about 6 rings, and the tree rings inside these two groups being read singly, d the sub-surface phenomena occurring inside these ngs would not be considered as "annual rings" h any scale-readers.

(4) The existence of rings in the outer part of the

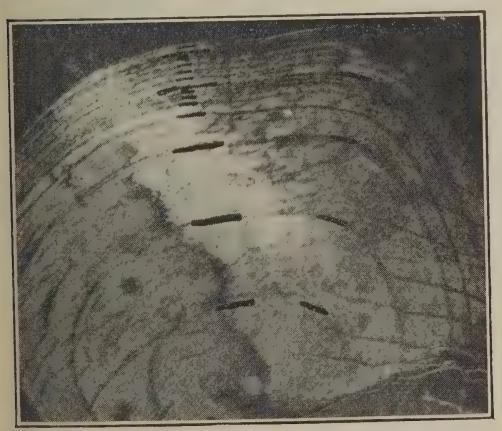


FIG. 3.—Showing three single rings and two groups of rings.

ale having stronger optical value than neighbour-ng rings, but similar optical value to the first 3 or winter rings. These strong or "α" rings can ften be traced out into the exposed part of the ale. If only these "α" rings are recognised as inter rings the age-estimate is of course lower han in the reverse case.

The above phenomena form the main basis of ny disagreement with the Norwegian theory. To ention further evidence for my views or to describe ny alternative theory would extend this beyond he bounds of a letter, but such evidence exists and will be laid before any workers interested in the matter. The scales from which the photos, here reproduced (Figs. 1-3), were taken, and many others, are also open to inspection.

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Ministry of Agriculture and Fisheries,
Fisheries Laboratory,
Lowestoft, July 17.

The Band Spectrum of Boron Monoxide.

IN two recent letters to NATURE (May 24 and 31) Mr. W. Jevons has questioned the adequacy of my evidence as to the oxide origin of a band spectrum which he had previously ascribed to boron nitride.[1] In his second letter he reports that these bands are absent from the spectrum of the discharge through a mixture of BCl_3 and O_2, although the ordinary boric oxide bands are present. This he considers convincing evidence against BO as the emitter of the bands in question. In view, however, of evidence outlined below, a full account of which will appear probably in the *Physical Review*, there seems little room for doubt that the bands are really due to BO and not to BN. The other oxide bands may then be ascribed, as in the past, and in accordance with their complex character, to B_2O_3.

When generated by the reaction of BCl_3 with active nitrogen, the intensity of the BO bands shows a maximum when perhaps 0·5 per cent. of oxygen is present. If the nitrogen is purified beyond this point, using phosphorus, its degree of activation, as gauged by the intensity of the α bands of the afterglow, is increased markedly, finally approaching asymptotically an upper limit. Unlike the BO bands, the SiN bands, obtained by using $SiCl_4$ instead of BCl_3, are stronger the less oxygen is present, and are practically extinguished by the amount of oxygen most favourable for BO. These facts appear to disprove Mr. Jevons's suggestion that the weakening of the BO bands in very pure nitrogen is due to a decrease in its activity when the oxygen is all removed. Probably, if this stage of purification was approached, phosphorus vapour replaced oxygen as a catalyst.

When the BO bands are at their strongest, the yellow of the α bands and the blue of the β bands of active nitrogen are roughly equal in intensity. Lord Rayleigh has shown[2] that the β (and γ) bands are due to the presence of oxygen, probably as NO. Prof. R. T. Birge has concluded[3] that the α bands are emitted by (metastable) excited N_2 molecules; also (private communication) that the β and γ bands are due to NO.[4] The formation of the emitters of the BO bands may then proceed somewhat as follows, denoting an electronically excited molecule by an accent (′):

(1) $BCl_3+N_2' \rightarrow BN+NCl_3$. (2) $BN+NO' \rightarrow BO'+N_2$.

Or, the formation of BO′ may be more direct; in any case, some BN is probably also formed,[1] but apparently gives no spectrum.

In repeating Mr. Jevons's recent experiments, I have found the B_2O_3 bands best brought out with a very large excess of oxygen over BCl_3. Under these conditions the ratio of excited BO to excited B_2O_3 molecules present and emitting at any moment may well be negligibly small, in view of the chemically highly unsaturated character of BO. In active nitrogen,

[1] W. Jevons, Roy. Soc. Proc. A, 91, 120-34 (1915).
[2] Roy. Soc. Proc. A, 93, 254 (1917).
[3] *Phys. Rev.*, 23, 295 (1924).
[4] E. P. Lewis (*Astrophys. Journ.*, 20, 49, and 58 (1904)) has shown that the γ bands are, without much doubt, due to NO; and Birge finds that the β and γ bands have a common final state. Also, their simple structure indicates a diatomic emitter.

however, consisting of a small proportion of N_2' and NO′ molecules in a medium chiefly of unexcited and so inert nitrogen, and with no continuous exciting discharge, this ratio may well be reversed, especially in view of the probable mode of formation of BO.'

In some experiments with a carbon arc,[5] the anode of which contained BN, B_6C, or B_2O_3, I have found that in all three cases the BO (and the B_2O_3) bands appear, in moderate intensity, when an atmosphere of oxygen or air is used, but that they are completely absent in nitrogen. In the latter case BN is doubtless formed, but does not emit a spectrum. No doubt B_2O_3 is partly dissociated into BO at the high temperature of the arc. In the lower temperature of the flame only the B_2O_3 bands are known to occur.

The final piece of evidence is the very close agreement of the vibrational isotope effect with theory for BO, and its definite disagreement for BN. In view of the strength of the theory, this by itself makes BO very probable. If the bands were due to BN, the agreement of experiment with theory would become qualitative only; and if this were the case, the chance is very small that the deviation of the theory from quantitative correctness would be just such as to correspond to an exact but illusory quantitative agreement for BO. The following empirical equations represent within experimental error the positions of all the measurable BO band heads:[6]

$$B^{10}O:\ \nu_\alpha = \begin{Bmatrix} 23652{\cdot}2;\ 23638{\cdot}9 \\ 23526{\cdot}0;\ 23512{\cdot}7 \end{Bmatrix} + 1285{\cdot}6n' - 11{\cdot}7n'^2 - 1926{\cdot}8n + 12{\cdot}21n^2$$

$$B^{11}O:\ \nu_\alpha = \begin{Bmatrix} 23661{\cdot}6;\ 23648{\cdot}3 \\ 23535{\cdot}4;\ 23522{\cdot}1 \end{Bmatrix} + 1247{\cdot}9n' - 10{\cdot}6n'^2 - 1873{\cdot}2n + 11{\cdot}68n^2$$

Ratio: (*Difference* = −9·4) 1·0302 1·104 1·0286 1·045

$$B^{10}O:\ \nu_\beta = 42874{\cdot}6 - 0{\cdot}19nn' + 1304{\cdot}6n' - 10{\cdot}43n'^2 - 1927{\cdot}9n + 12{\cdot}66n^2$$

$$B^{11}O:\ \nu_\beta = 42880{\cdot}9 - 0{\cdot}17nn' + 1268{\cdot}8n' - 9{\cdot}98n'^2 - 1872{\cdot}9n + 11{\cdot}84n^2$$

Ratio: (*Difference* = −6·3) 1·0282 1·045 1·0294 1·069

For the coefficients of the linear terms, the theoretical ratio is 1·0292 for BO and 1·0276 for BN; for the quadratic terms, 1·0593 for BO and 1·0560 for BN. The mean of the four experimental values is $1{\cdot}0291 \pm 0{\cdot}0004$ for the former, $1{\cdot}066 \pm 0{\cdot}010$ for the latter.—The coefficients of n and n^2 indicate a common final state for the α and β systems.

A remarkable feature of the BO bands is the non-coincidence, for the bands having the vibrational quantum numbers n and n' both zero, of corresponding heads of the two isotopes. For the centres of these bands an approximate correction, based on measurements of band structure, increases the differences recorded above to −10·0 and −7·2 for the α and β systems respectively. According to the theory as now accepted, these corrected differences must represent electronic isotope effects, of much greater magnitude than have been found in line spectra. Since this is highly improbable, the following alternative explanation is decidedly to be preferred. If one assumes that the true values of the vibrational quantum numbers are not n and n', but each $\frac{1}{2}$ unit greater, the apparent isotope effect for the true vibrational zero point is reduced to −2·2 for the α and +2·4 for the β system. These differences are now small enough to have resulted from inaccuracies in the determination of equation coefficients. It is then probable that the minimum vibrational energy of BO (and doubtless of other) molecules is $\frac{1}{2}$ quantum. In the case of molecular rotational energy, the necessity of using half quanta is already well established. Analogous relations appear in line spectra; *e.g.* Heisenberg[7] has successfully used half-integral radial and azimuthal quantum numbers in explaining structure and Zeeman effect of doublets and triple

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[5] Similar experiments by Jevons (*l.c.*) on a boron arc were inconclusive, although favouring the nitride origin of the BO bands.

[6] It can be shown that no appreciable error is introduced here in the isotope ratios by using data on heads. The nn' terms are due to the fact that the data are for heads.

[7] W. Heisenberg, *Zeit. für Physik*, 8, 273 (1922).

Effect of Length of Day on Flowering and Grow

AN attempt has been made to confirm the worl Garner and Allard [1] done in America, under the c ditions prevailing in Britain at the Welsh Pl Breeding Station, and to test particularly the haviour of various strains of herbage plants un different lengths of day.

The plants, equal propagants, or pure line pla were grown in pots or boxes placed on trucks wh were run in and out of a three-sectioned hut so t they received 12, 9, and 6 hours' daylight. Con plants received the full natural daylight. Equal s water, and temperature conditions were provided far as possible.

The results obtained fall into three divisio namely:

I. EVER-BLOOMING TYPE.—Plants of *Poa Am* flowered normally under all light periods.

FIG. 1.—American Red Clover, photographed on July 29, showing, le right, control (many heads ripening), 12-hour plant (with small flow 9-hour plant (almost prostrate, with a few small heads), and 6-h plant (prostrate, in winter habit).

II. SHORT-DAY PLANTS—*Chrysanthemums* (v Mrs. William Buckingham): Subjected to treatm on May 9. Short-day plants, flower buds July open in early August. Controls, no buds August *Phaseolus vulgaris* (Runner Bean, Sutton's "Best All"): Treated plants were small and bushy, w thick nodes and swollen roots. Height of cont plants 50 in., height of 6-hour plants 9 in. Treat plants flowered 4 days earlier than control plants.

III. LONG-DAY PLANTS—(1) *Broad Red Clover* (Suffolk): Control plants started flowering May attained flowering zenith June 6; 12-hour pla started flowering June 28, attained flowering zen July 26; 9-hour plants started flowering July attained flowering zenith July 31; 6-hour pla have remained entirely in the winter habit. *Montgomery Variety*: Controls flowered freely fr July 16, reaching their flowering zenith about Ju 26. The 12-, 9-, and 6-hour plants were quite pr trate and in the winter habit on August 10.

[1] "Effect of Relative Length of Day and Night and other Factors of Environment on Growth and Reproduction in Plants," W. W. Garner H. A. Allard (*Journ. Agric. Res.*, vol. xviii. No. 11, p. 553); "Further Stu in Photoperiodism, the Response of the Plant to Relative Length of Day Night," W. W. Garner and H. A. Allard (*Journ. Agric. Res.*, vol. xxiii. No. p. 71, 1923); "Photoperiodism in Relation to Hydrogen ion Concentratio Cell Sap and Carbohydrate Content of the Plant," W. W. Garner, C. Bac and H. A. Allard (*Journ. Agric. Res.*, vol. xxvii. No. 3, p. 119, 1924).

ksfoot.—Some of the Cocksfoot results can be rmarised thus :

	First Panicle emerging.	Full Flowering (Pollen).	Ht. on 31/7.
rch Hay " strain :			
rol plants	19/5	5/6	34 in. ripe seed.
our plants	6/6	16/6	15 in. ripening.
ur plants	Remained in winter habit, good leafy growth, no signs of panicles at all, 6/8/24.		5 in.
ur plants			
ocks " type :			
rol plants	29/5	25/6	27 in. ripening.
our plants	30/6	29/7	9 in. full flowering just over.
ur plants	Plants as yet in winter habit, 6/8/24.		
ur plants			

liefly, the following have proved to be " long-day " ats :

asses.—Sweet Vernal, " Late " and " Early d Leaf " strains ; Meadow Foxtail, " Late ure " strain, " Early Hay " strain ; Cocksfoot

Fig.—Montgomery Red Clover, photographed on August 2, showing, ft to right, 9- and 12-hour plants quite prostrate in winter habit and ontrol plant flowering.

strains, " French Hay," " Danish Open," " Late Indigenous," and " Tussocks " ; Perennial Rye Grass, Early and late strains ; Timothy, Early strains. *Red Clover.*—Broad Red, American Medium, and Montgomery. *Oats.*—Grey Winter, Record, Orion, Ceirch duBach. *Radish.*—Scarlet Globe. *Foxglove.*

A more detailed account will appear shortly elsewhere. Thanks are due to Prof. R. G. Stapledon, who arranged for the necessary equipment and provided facilities for conducting the work, and to Mr. J. W. Watkins, Superintendent of the Welsh Plant Breeding Station Gardens, for careful attention to cultural detail. M. A. H. Tincker.

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University College of Wales,
Aberystwyth.

The Insect Fauna of an Indian Island.

It has been my good fortune to be associated with the late Dr. N. Annandale in the study of the fauna of a small island in the Chilka Lake, Orissa—the first work of its kind in India. This study has, I believe, a general interest, and I need scarcely apologise for presenting this brief analysis of the insect fauna of this island.

The physical features of Barkuda Island form the subject of a memoir by Annandale (1922), but it may be recapitulated here that the island is situated in the Chilka Lake on the east coast of India in lat. 19° 38′ N. long. 85° 12′ E., and lies in the extreme north-western corner of the Madras Presidency. In outline it forms a right-angled triangle, its longest side being about three-quarters of a mile long, and its shortest less than half as much : the total area equals about half a square mile. It is composed of stratified rocks covered in the interior with a thin layer of red soil, its geological nature, combined with a low average rainfall (as compared with that of the mainland), being responsible for the sclerophytic nature of its vegetation, a distinctive feature of which is the fig-jungles in which there is a dense undergrowth composed mainly of the shrub *Glycosmis pentaphylla*. The dominant tree in these ficetii is the Banyan (*Ficus bengalensis*), the decayed trunks of which are largely inhabited by termites. In inland areas where there is no ficetum, *Weihea ceylonica* is the dominant shrub, and the fig-trees are replaced by the Nim (*Barringtonia acutangula*) and *Craeteva religiosa*. The island is almost completely surrounded by a marginal zone of the trees of *Pongamia glabra*. Other common plants are the Euphorbias (*E. neriifolia* and *Opuntia* sp.), the Custard-apple (*Anona squamosa*), and the herbs *Crotolaria striata*, *Tephrosia purpurea*, and

Fig. 1.

Jatropha gossypifolia. Barkuda is separated from the mainland of the western shore of the lake by a channel only a mile broad, and is thus not out of the range of insect immigrants, even those of comparatively feeble flight.

Dr. Annandale's main object in studying the fauna of the island was that it provided an easy means of ascertaining the faunal and floral constituents of a limited area in the tropics, of a somewhat commonplace nature, and the results provide an interesting comparison with the biological features of other areas in the East. It was found that the species of insects inhabiting the island exhibited no morphological peculiarities in response to an unfavourable environment, but were for the most part common and widely distributed species able to exist on the island by reason of their physiological " hardness," or because they could adapt themselves to feed on strange and not very delectable food-plants. It would seem that a rich flora tends to produce a large and varied number of insect forms with a comparative scarcity of individuals, while the insect fauna of such areas as Barkuda are poor in species but rich in individuals.

In the accompanying diagram (Fig. 1), I have attempted to indicate (relatively) the approximate number of forms of the various orders (used in the old sense, *e.g.* Neuroptera to include Odonata, etc.) found on the island. It must be remembered that the totals include regular visitors and stray immigrants to the island. Geographically it seems to be part of the frontier between the faunas of the central and southern districts of the Indian peninsula. *Per exemplum* Barkuda appears to represent the extreme north-eastern limit in India of the dis-

tribution of the Pierid butterfly *Colotis calais amatus*. The South Indian element is strongly noticeable in its insect fauna. In the diagram, the total for "Hymenoptera" includes only the Aculeates; three-quarters of the neuropteroid insects are dragon-flies.

In the space at my disposal it is not possible to consider any special characteristics within the various orders. I may mention, however, that much taxonomic and bionomic information has been accumulated (especially with reference to the termites), and the reader is referred to the various reports on the fauna of the island. A considerable number of new forms have also been described, including such interesting insects as the hemipterous termitophile *Termitaphis annandalei* Silvestri. At some future date a complete summary may be provided.

See Rec. Ind. Mus., xxii, pp. 313-421, 1921; xxiv, pp. 289-311, 1922; xxv, pp. 221-263, 1923; xxvi, pp. 165-191, 1924 (various authors). Also Annandale, Mem. As. Soc. Bengal, vii, p. 257, 1922.

CEDRIC DOVER.

London, July 25.

On the Spectrum of Ionised Potassium in Connexion with the Red and Blue Spectrum of Argon.

BY Zeeman and Dik (Proc. Amsterdam 25, 67, 1922), and Dik and Zeeman (Proc. Amsterdam 26, 500, 1923), it was found that in the electrodeless discharge (observations of McLennan, Dik and Zeeman) most of the lines of ionised potassium between 6594 Å and 3063 Å could be arranged in quadruplets.

If the frequency of the first line of each quadruplet is designated P, and the succeeding ones Q, R, S, it was found that

$$Q = P + 847$$
$$R = P + 1695$$
$$S = P + 2542.$$

For the red spectrum of argon, exhibited under the uncondensed discharge, and for λ below 4704 Å, Rydberg, in 1897, found a similar regularity. Paulson extended those results, and Meggers increased their accuracy. The frequency relations for the red argon spectrum are, with similar notations:

$$B = A + 846{\cdot}1$$
$$C = A + 1649{\cdot}3$$
$$D = A + 2256{\cdot}1$$

In both cases some of the "quadruplets" are incomplete. It is certainly remarkable that the number 847 occurs in both spectra.

We have extended the former investigation and have included an analysis of the "blue spectrum" of argon developed by the condensed discharge.

The following table contains the new results, together with those formerly given.

Argon, Red Spectrum (Rydberg).	Argon, Blue Spectrum.	Ionised Potassium.
A	p	P
$B = A + 846$	$q = p + 845$	$Q = P + 847$
$C = A + 1649{\cdot}3$	$r = p + 1695$	$R = P + 1695$
$D = A + 2256{\cdot}1$		$S = P + 2542$
	t	T
(411,57)	$u = t + 414$	$U = T + 413$

From this table it appears that the connexion between the spectra of ionised potassium and argon (blue) is closer than that between the spectra of ionised potassium and argon (red). We find the numbers 414, 845, 1695 characteristic for the blue spectrum of argon. The number 847 or thereab occurs with red argon, blue argon, and ion potassium; moreover, 1695 links blue argon ionised potassium.

Then there is the number 414, which occurs, as find, in numerous doublets of ionised potassium argon (blue). It may be mentioned that Rydb directed attention to the occurrence of the num 411·57 in the red spectrum of argon.

That there is a close numerical connexion betw the three spectra considered seems proved, but physical interpretation of the characteristic numb is quite unknown.

Tables and calculations will be published elsewh

T. L. DE BRUIN
P. ZEEMAN.

Amsterdam, August 15.

Anomalous Adsorption.

BILTZ and Steiner (*Kolloid-Zeitschrift*, 1910, 7, 1 have described several cases of so-called "anoma adsorption," for example, the adsorption of N Blue and Victoria Blue B. by cotton and charc The adsorption isotherms rise to a maximum and off again with increasing concentration of the c stuff. Hatschek in his "Physics and Chemistry Colloids," 1922, p. 146, suggests that electrical fac may complicate adsorption "though these do very readily account for the maximum." Durin study of the dyeing of wool by Night Blue I h obtained adsorption curves of the same peaked fo using the same colorimetric method of estimation Biltz and Steiner. On examining the dyed w however, it could not be said that the colour was lighter in the case of the more concentrated soluti and some defect was therefore sought in the met of experiment.

It had been noticed that the dyestuff solut remaining after adsorption on the wool had a green blue colour when viewed by transmitted light in colorimeter, whereas the original Night Blue solut were a pure blue; this gave the clue to the def Although Night Blue solutions appear to contain free chlorine ions, the solutions remaining after sorption were both acid and contained chlorine i Hydrochloric acid is probably produced during sorption, and this has been shown to have a profo influence on the colour of Night Blue solutions. 2, 3, and 4 c.c. of a very dilute hydrochloric a solution were added to the same amounts of dyes solution and made up to the same volume with tilled water. These solutions were compared col metrically with a standard Night Blue solution of same concentration but containing no acid. If denote the concentration of the standard by un the *apparent* concentrations of the acid solution order were found to be 1·28, 1·50, 1·83, and 2 Furthermore, they showed the same greenish-b colour noticed previously. In the adsorption Night Blue by wool the amount of acid libera will increase with the amount of dye adsorbed, in consequence of this acid the apparent amoun dyestuff unabsorbed, estimated colorimetrically, be increased. Since the amount of dye adsorbe estimated by difference (original concentration kno the explanation of the peaked adsorption isothe is self-evident, and "anomalous adsorption," as scribed by Biltz and Steiner, has probably no existence. The determination of the true adsorpt curve is in progress.

JOHN B. SPEAKMAN

The University, Leeds.

Species and Chromosomes.[1]

By Prof. R. Ruggles Gates.

'is only since the beginning of the present century that the progress of biology has rendered possible ediscussion of this topic. When the "Origin of ecies" was written, chromosomes were unknown, ıd the study of nuclear division and the relation hromosomes to the life cycle only began in the enties and 'eighties of the last century. The names emming, Strasburger, Boveri, and many others are rected with the early work on chromosomes, when olic fixation and methods of sectioning first made ible their study. Flemming in 1882 first concluded 24 chromosomes was probably a constant number ne nuclear divisions of the cells of the Salamander. he following year van Beneden discovered, in ris, that the egg and sperm contained half as many mosomes as the somatic cells. From that time to the process of chromosome reduction has been ied with increasing intensity. Its general relation ne life cycle is now known in nearly all the larger ps of plants and animals.

ntil the end of the nineteenth century the study of structure developed quite independently of views rding heredity and evolution, although it had often en suggested that the chromosomes formed the basis heredity, and that they consisted of differentiated ions or elements. The rediscovery of Mendel's in 1900 was the beginning of a remarkable conver- e between two independent disciplines, the micro- oic study of cells and chromosomes on one hand, the observational and experimental study of edity and evolution on the other. There is no more king instance than this, of the convergence of two ependent lines of investigation, in the whole history biology.

t is equally significant that the advances in our wledge of chromosomes have been alternately based n studies of plants and animals, sometimes one and metimes the other being the basis of a particular new e of advance. Whichever has taken the first step in articular new line of departure, it has usually found firmation from the other. Even sex chromosomes, ich were first discovered in insects and were most ensively investigated in that group, are now known occur not only in mammals, including man, but also ertain Liverworts and in certain dicœcious flowering nts. Nothing so strikingly proclaims the unity of organic world as the profound similarity which has n shown to exist in the fundamental cellular pro- ses of the two kingdoms.

Moore had discovered synapsis, or the contracted se of the nuclei preceding the reduction divisions, Elasmobranch fishes, in 1896. It was believed that pairing of elements took place at this period of turation. In 1901 Montgomery suggested that napsis consisted in a conjugation of homologous nternal and paternal chromosomes before their paration in the reduction division. Guyer (1900), in tudy of spermatogenesis in pure and hybrid pigeons, d already pointed out that the separation of the pairs of chromosomes would account for cases of reversion in hybrids. In short, the chromosome mechanism was recognised as furnishing a basis for what we now call Mendelian behaviour at the same time that Mendel's laws were made known. A similar suggestion was made by Cannon (1903) in a brief study of the reduction divisions in hybrid peas.

Sutton in 1903 produced definite evidence of the pairing of homologous chromosomes of different sizes and shapes in the grasshopper Brachystola. In 1905 Strasburger showed the same arrangement of homologous chromosome pairs in plants, and in the same year Farmer and Moore suggested the term "meiosis" for the whole process of chromosome reduction.

For the original recognition of the individuality, or to use Wilson's term, the genetic continuity of chromosomes, we are largely indebted to Boveri, although the general acceptance of this view has resulted from an enormous amount of later detailed evidence. Among this evidence an important place is occupied by the work on hybrids, including that of Rosenberg (1904) on a species hybrid of Drosera, of Moenkhaus (1904) on hybrid fishes, and of Doncaster, Gray, Tennant, and others on generic hybrids of echinoderms, as well as the more recent experiments of Federley on species hybrids of the moth Pygæra. In all such cases the parental chromosomes maintain their characteristic differences of form and behaviour in the hybrid. These and a host of other results show that the chromosomes are not only self-perpetuating entities, through longitudinal division, but that they are also self-determining as regards their form, and we may now add as regards the finer elements of their structure.

In the last fifteen years particularly, the alliance between cytology and genetics in the experimental study of heredity and variation has become increasingly intimate. Beginning with the recognition of chromosome segregation in meiosis as the basis of Mendel's law of heredity, this was soon followed by the discovery (1906) of definite relations between chromosome numbers and mutations in Œnothera. Since 1910 Morgan and his colleagues have built up a combined system of genetical and cytological results in Drosophila which is unequalled in any other organism. Their theory of linkage and crossing-over has brought the phenomena of meiosis, chromosome structure, and heredity into still closer relationship. More recently Blakeslee and Belling have discovered chromosome relationships in Datura which parallel many of those formerly obtained with Œnothera, and in a striking series of experiments have extended those results in various directions.

In recent years, a number of predictions of peculiar cytological conditions have been made on the basis of genetic experiments, and afterwards confirmed by observation of the cells. An example is the work of Bridges with strains of Drosophila having an extra chromosome. This condition arises, as was first shown in Œnothera, through failure of one pair of chromosomes to enter separate nuclei in reduction, a process which is now known as non-disjunction.

The following may now be regarded as generally

[1] Opening paper of a joint discussion of Sections D (Zoology) and K (Botany) at the Toronto meeting of the British Association on August 12.

accepted facts concerning the chromosomes. They are bodies of relatively fixed size, shape, and point of attachment to the spindle fibres. Homologous pairs usually separate in meiosis and thus furnish the basis for simple Mendelian behaviour. Their number is generally fixed for each species so far as the germ-lineage is concerned. The relations of genetical crossing-over to chromatin behaviour are complicated and need not concern us here. Aberrant chromosome numbers arise in various ways and produce forms with different external characters. Such forms have been specially investigated in Œnothera, Drosophila, and Datura. The most striking changes found are tetraploidy ($4n$ chromosomes), triploidy ($3n$), and non-disjunction leading to forms with an extra chromosome ($2n+1$, $4n+1$, etc.). These conditions occur in all three genera, except that tetraploid forms have not been observed in Drosophila. The condition found in Œnothera particularly furnished the first experimental basis for a comparison of the chromosome numbers in various wild and cultivated species of plants.

When we examine the chromosomes of related species of plants and animals, differences in number or in size and shape of the chromosomes are often found. How have these differences originated? The answer to this question has already given us the beginnings of a chromosome phylogeny, which can now be soundly based on analogy with experimental results. The case of *Œnothera gigas* furnished the first experimental clue to the origin of tetraploidy. Many wild tetraploid species of plants are now known, and they must have arisen in some such way as *Œ. gigas* appeared, *i.e.* as mutations. The tetraploid and higher polyploid species are turning out to be surprisingly common in plant genera, though apparently much less frequent in animals.

Before considering further the phenomena of polyploidy, let us attempt to classify the various types of change which are indicated to have taken place in the phylogeny of chromosomes by the comparison of related species or genera. We may mention:

1. Polyploidy, or the development of higher multiples of chromosome numbers.

2. Transverse segmentation or fragmentation of all the chromosomes, or of particular pairs. A phenomenon of this nature seems to have occurred on a large scale in the phylogeny of the Liliaceæ, where in such genera as Yucca, Albuca, and Eucomis, a number of pairs of short chromosomes take the place of certain long pairs in other genera. In the tetraploid *Primula Kewensis*, a transverse segmentation of all the chromosomes is shown by measurements (Farmer and Digby) to have taken place. In certain species of Hyacinthus and Carex the sum of the lengths of a medium and a short chromosome is equal to the length of a long one, indicating that transverse segmentation of a long one may have taken place.

3. The end-to-end fusion of certain chromosomes. This is particularly clear, both from genetical and cytological evidence in certain species of Drosophila, and appears to have happened in various other cases. The basal number of chromosomes in the Muscidæ appears to be 6 pairs. In different species of Drosophila the n number may be 6, 5, or 4. In *D. melanogaster* and *D. Willistoni*, which have 4 pairs, two of these are long and broadly V-shaped, with a med constriction, and each of these has evidently b formed by the permanent end-to-end attachment two chromosomes. That *different* chromosome p have undergone this union in these two species shown by the different genetic relationships of t characters in breeding experiments; and that tendency towards end-to-end union still continues indicated by the recent discovery of a strain of *melanogaster* in which the two X-chromosomes in females have similarly become attached to each ot and behave as a single body.

4. The gradual diminution in the size of cert chromosomes until they disappear. That this evo tionary process has occurred in the Y-chromosome various insects, is indicated by its range of size different species, from as large or even larger t its mate the X-chromosome in some species, to a t body on the verge of extinction in others. Wil showed, for example, in the Hemipteran genus Nez that the Y-chromosome is nearly as large as the X *N. hilaris*, but very small in *N. viridula*.

In the Copepod genus Cyclops a gradual diminut in the number of chromosomes, from 22 in *C. stren* to 6 in *C. gracilis*, is accompanied by reduction in fifth pair of swimming feet. In another section the genus a parallel process has apparently occurr with corresponding gradual diminution of the chro somes from 14 to 10 and a small pair. Here phy genetic change has apparently been accompanied the continuous diminution in size of certain chro somes until they disappear. Whether such a proc should be looked upon as an orthophyletic cha arising in the germplasm is not at present clear, the subject is evidently worthy of further investigati

5. Irregular divisions or non-disjunction may l to forms with additional pairs of chromosomes. this condition becomes balanced it would be p petuated in a new species. This may have happe in various species.

6. The recent genetic evidence from Drosophila a the behaviour of the chromatin in such forms *Œnothera lata*, indicate that not only may chroma fragments enter a nucleus and afterwards divide, also that portions from one chromosome may beco attached to another and thus alter the genetic relati ships of the factors concerned. This process is which must also be considered as important in evolution of species.

7. In the genus Carex, Heilborn (1924) has sho that the haploid numbers in forty-four species from 9 almost continuously to 42 and 56, but with multiple numbers. With increase in numbers th is a general decrease in size of the chromosomes, a the same is true of certain other genera, such as Lactu This is regarded as due to a limitation in the capac of the cell for producing chromatin. Heilborn sugge that one of the most important methods of chro some increase in Carex has been by mutations of *Œnothera lata* type followed by a division of the ex chromosome.

8. Certain species and even genera with new chro some content have probably arisen through crossi There is some evidence, both cytological and morp logical, that cultivated maize may have arisen fro

cross between the Mexican Euchlæna and some species of grass belonging to the Andropogoneæ. A much rarer case is the one recently described by J. Clausen. He finds that *Viola tricolor* and *V. arvensis* have respectively 13 and 17 chromosomes as haploid numbers. In a cross the F_1 plants have 30 chromosomes, but in certain of the pollen mother cells 47 were found, *i.e.* 13+17+17, a condition of semi-tetraploidy. Two later generations of plants were grown from these hybrids, the chromosome number continuing 43-46. When the chromosome number is a very unbalanced one in a hybrid, as in crosses between diploid and tetraploid forms, irregularities of meiosis usually occur with loss of chromosomes until the diploid condition is reached in the later generations of offspring. In this Viola hybrid, with less disparity in numbers and a doubling in one parental set of chromosomes, the hybrid may later settle down to uniformity, in which case it might be regarded as a new species with higher chromosome number arising from crossing. Probably various species with increased chromosome numbers have been produced in this way, as Winge has suggested.

It is thus becoming clear that chromosome changes have arisen in a variety of ways, including transverse segmentation or fragmentation, end-to-end union of certain pairs, gradual diminution and disappearance of certain chromosomes, non-disjunction, rearrangement of portions of chromosomes, crossing of species having different numbers, and polyploidy. In some of these cases, of course, a certain amount of nuclear and cytoplasmic readjustment may be involved, but we have no present knowledge of how this takes place. In the simplest cases of tetraploidy all the external changes appear to follow directly from the doubling of the chromosomes.

All of these processes of chromosome change have had their place in the evolution of the germplasm, but certain of them appear to have been characteristic of particular genera or families. Our knowledge of polyploidy is at present much more extensive than any of these other processes, and it is on an experimental basis.

From the work of the last fifteen years, it has become clear that polyploidy has played an important part in the evolution of many plant genera and families, and that it is of particularly common occurrence among the varieties of cultivated plants. If tetraploidy can be brought about, as seems likely, by a lowering of temperature when the fertilised egg is beginning to divide, then one may perhaps understand its prevalence in plants and its relative infrequency in animals where temperatures are more controlled. But that it can be produced in other ways is shown by its experimental production in mosses by wounding (Marchals), in Solanum by grafting (Winkler), and semi-tetraploidy at least by crossing.

The cases of polyploidy in plants that have now been investigated are far too numerous to be discussed here, but reference may be made to a few of them. The genus Rubus, in which Longley (1924) has recently found $2n$, $3n$, $4n$, $5n$, $6n$, and $8n$ species, has 7 as basal number. The basal number of chromosomes in Rosa is also 7. In the genera Prunus and Potentilla the fundamental number is 8, and several species of Potentilla are known to be tetraploid. In Cratægus, where $n=16$, Longley (1924) has found $2n$, $3n$, and $4n$ species. If 16 is the fundamental number in this genus, then the genus must have originated in connexion with a tetraploid mutation. In some species of Alchemilla $2n=64$ and they are therefore octoploid in comparison with the fundamental number. It is evident that further chromosome studies in such families as the Rosaceæ will throw light on the origin and relationships of genera. The fact that such notoriously polymorphic genera as Rosa, Rubus, and Cratægus are all found to show polyploidy in a high degree is a discovery too fresh for its significance to be fully realised.

Similarly in the evolution of various other genera and families, higher and higher polyploid numbers have been reached. Thus in the genera Chrysanthemum, Rumex, and Rosa, species are found which are $2n$, $4n$, $6n$, and $8n$ in their chromosome constitution. Some of these genera also have $3n$, $5n$ and even $10n$ species. Many of these species are apogamous, and where the chromosome number is an unbalanced one as in $3n$ and $5n$ species, it can only be maintained by apogamous or vegetative reproduction. Thus these unbalanced species must always have been apogamous from their origin.

The conditions in the wheats, where $n=7$, may be briefly mentioned. Einkorn wheat (*Triticum monococcum*) is diploid, the species of hard wheat are tetraploid, and the Vulgare wheats (soft), which comprise our highest yielding modern sorts, are hexaploid. When members of different groups are intercrossed they produce sterile hybrids. All three groups go back to prehistoric times. The tetraploid wheats presumably arose, like *Œnothera gigas*, through a sudden doubling in the number of chromosomes. The most probable hypothesis of the origin of the $6n$ condition is that it came from a $3n$ hybrid between diploid and tetraploid species, one such hybrid having doubled its chromosomes, perhaps in the fertilised egg, and so restored its fertility. In certain cultivated varieties of mulberry, the $3n$ condition is maintained by apogamy, and the same is true of the wild species *Eupatorium glandulosum* and *Erigeron annuus*. Similar polyploid conditions are being found in many cultivated plants, including bananas, pineapples, oats, and dahlias, so that much more evidence concerning the precise manner of origin of these conditions ought to be obtainable.[2] Enough is already known to show that several different kinds of, for example, tetraploidy exist.

The development of sterility between species has undoubtedly played an important part in evolution. How this condition has come about is still a matter of speculation, but we are beginning to get some light on the subject. The old view that forms which produced fertile hybrids must belong to the same species has completely broken down, as has the converse conception that in plants, sterile pollen is a proof of hybridity. One of the most interesting features of tetraploidy is its relation to the development of sterility. As has been pointed out elsewhere,[3] if a tetraploid form such as *Œnothera gigas* arises in Nature, its hybrids

[2] Some of these subjects have been more fully discussed elsewhere Polyploidy, *Brit. Journ. Exptl. Biol.*, I, 153-182, 1924.
[3] NATURE, 1922, vol. 110, pp. 179, 447.

with its diploid parent must contain an unbalanced chromosome content, and this leads to the dropping out of chromosomes in later generations until the diploid number is restored.[4] The triploid form can only perpetuate itself by developing apogamy (as certain triploid species and varieties have done) or by doubling its chromosomes, thus producing a hexaploid form. In all three cases new centres of stability will be reached, which are starting points for fresh variations. The essential conditions for physiological isolation are produced, because the cross-breds will be unbalanced and unable to perpetuate themselves, while the original diploid and tetraploid forms will go on as independent lines of descent.

Blakeslee [5] and his collaborators have recently gone a step further and made the important discovery that the tetraploid mutation from Datura is almost completely sterile with its diploid parent. This is the first time that a form has been shown to appear in cultivation which is sterile with the form that produced it. In other respects it appears to be a complete parallel to the case of *Œnothera gigas*. It is thus proved not only that germinal changes can take place leading to new centres of variation, but also that they may be accompanied by practically complete sterility with the parent form. The origin of species which fail to cross with their parents, or of forms which produce sterile hybrids, is thus seen to be concerned in many cases with morphological changes in the chromosome content, such as tetraploidy.

In this way tetraploidy and the higher forms of polyploidy, as well as other types of chromosome change, have been of great importance in evolution, since they have the effect of physiological isolation even when there is no isolation in space. Genera and species which are tetraploid in comparison with related forms may be expected to have arisen in Nature in this way. Nor is this condition confined to higher plants, since various mosses and ferns, and Isœtes, are known to show similar conditions.

The study of chromosomes thus leads to results of far-reaching importance for evolution. It is of the highest importance for taxonomy in determining the relationships of species and genera. With advancing knowledge and quicker methods of examining chromosomes, the time should come when the description of a species is not considered complete until the morphology of its chromosome group is known, for visible chromosome differences, when they occur, throw important light on relationships. With further knowledge we shall doubtless learn much concerning the phylogenetic nature of the various kinds of chromosome change which have been outlined here. They suffice to indicate that there is a fundamental evolution of the germplasm, of which changes in specific characters are merely the external expression. Already as regards tetraploidy these changes have been experimentally analysed and we know something of the conditions which bring them about.

How the environment, acting on the organism, may have influenced other kinds of chromosome change we do not know at present. But it is well to remember that if a radium atom can undergo spontaneous change and break-down, then the infinitely more complex physical arrangement involved in a group of chromosomes may be reasonably expected to undergo equally spontaneous changes, especially during the complicated process of meiosis. It may also undergo alterations in which the environment of the cell has only been very slightly concerned. As an additional means of investigating phylogeny, the chromosomes have already furnished evidence of the highest importance, and their further study will no doubt throw important light upon the methods of evolution.

Modern genetics has led us to deal, as Bateson has said, with the world of gametes which form the background for the visible inherited variations of species. The next decade of comparative and experimental work with chromosomes will bring the realisation that in the secular changes of the chromosomes, however controlled or determined, we have a means of understanding how the cell unit, and through it the organism, has varied in structure in the past from species to species. This gives a new line of approach, of fundamental importance, in the analysis of the processes of evolution. It is to be hoped that its significance will be recognised not only by experimental evolutionists as an additional line of evidence in tracing phylogenies, but also by taxonomists as a necessary element in their discrimination of genera and species.

From a phylogenetic point of view, two important principles have emerged from the work of recent years in experimental evolution and other fields. One of these is the principle of parallel mutations, which introduces a new element of fundamental importance into the reconstruction of phylogenies. The original case of parallel mutations experimentally determined was that of the *lata* mutation from *Œnothera Lamarckiana* and from *Œ. biennis*, both mutants having 15 chromosomes and the same peculiarities of leaf and habit and sterile pollen, but each having the flower-size of the species from which it was derived. Innumerable cases of parallel variations are now known in plants, and many in animals. They appear to have originated as mutations. Vavilov, in particular, has directed attention to their frequency in cereals, Leguminosæ, and other families. When their significance is appreciated by systematists they will have a profound effect on present conceptions of relationships and phylogeny, for they show that many similar variations have occurred over and over again in unrelated groups.

The other principle to which I may make a brief reference has been emphasised particularly by palæontologists in recent years.[6] We may call it *orthophylesis* to avoid the special connotations of previous terms. It consists in the recognition of longer parallel phylogenetic trends in different lines of descent. What relation, if any, these orthophyletic trends bear to parallel mutations remains to be investigated. But it is possible that some of them, at any rate, as pointed out earlier in this paper, may be the result of changes initiated in the chromosomes. In any case the comparative study of chromosomes offers one of the most promising lines of advance in experimental evolution.

[4] See Gates, "The Chromosomes of a Triploid Œnothera Hybrid," *Ann. Bot.*, 37, 565-569, 1923.
[5] Blakeslee, Belling, and Farnham, "Inheritance inTetraploid Daturas," *Bot. Gaz.*, 76, 329-373.
[6] See Watson, D. M. S., Croonian Lecture, Royal Society, 1924 (NATURE June 7, p. 841).

The Light emitted from Solidified Gases and its Relation to Cosmic Phenomena.

By Prof. L. VEGARD, University of Kristiania.

IN previous communications [1] I have given accounts of investigations on light emitted from solid nitrogen exposed to cathode rays and its bearing on the auroral spectrum. The conclusion was reached that in the auroral region the temperature was so low that nitrogen existed partly in the form of minute crystalline particles. If these particles are of molecular order of magnitude, the state is very much like a gas, from which, however, it differs in one respect. The constituent particles are not molecules with identical mass, but each particle may contain a more or less arbitrary number of atoms arranged in a space lattice characteristic of the solid state. This state, which is something between a gas and a solid, we shall call a pseudo-gaseous state.

Although it is difficult or perhaps impossible to produce this pseudo-gaseous state in laboratory experiments, still I was able to show that a layer of solid nitrogen when bombarded with cathode rays of small velocity gave a spectrum which was essentially the same as the auroral spectrum. In the green, the spectrum from solid nitrogen consisted of two bands, N_1 and N_2, corresponding to the auroral lines 5577 and 5230, and in addition it showed in the blue and violet the band-heads which are typical for the auroral spectrum.

The work has been continued at the Cryogenic Laboratory of Leyden and I have been able to study the new effect under varied conditions, with different kinds of rays, and I have also experimented on layers of various gases. In order to determine more exactly the position and structure of the bands, I have used a spectrograph of considerable dispersion. With the largest dispersion used, the distance between the yellow helium line (5875·6) and the green helium line (5015·7) was 27 mm.

I have obtained about a hundred spectrograms of the light effect from solidified gases and made a number of interesting observations which will be dealt with in greater detail in a later work. In this article I propose to give a short and preliminary account of some of my recent results.

Already in my first publication I mentioned that while the line N_2 was fairly sharp, N_1 was broad and covered the spectral region 5525-5660, and further it showed some structure. The spectrograms at larger dispersion [2] showed that N_1 had three maxima, one strong and two weak.

The position of the maxima varies somewhat with the experimental conditions. From one of my spectrograms with large dispersion I find that N_1 covers a region between 5528 and 5655. For the principal maximum I find $\lambda = 5555$, and for the two weak ones 5611 and 5649. Also with the greater dispersion, N_2 appeared as a single but somewhat diffuse line with a wave-length 5229·4, which agrees very well with the wave-length (5230) given in my first publications.

So long as we are unable to experiment on a pseudo-gaseous state of solid nitrogen, we cannot make an exact comparison between the wave-length of N_1 and that of the prominent green auroral line. Under the conditions of the experiments, N_1 does not define any definite wave-length, and we can merely state that N_1 is extending on both sides of the auroral line. The sharpness of the latter must be due to the smallness of the particles, and the prominent green auroral line is to be regarded as the limiting aspect of the band N_1, when emitted from solid nitrogen particles of molecular order of magnitude, which exist in free space.

I have been able to make some experiments which actually show that the bands get sharper when the particles are reduced in size. When an inert gas which contains traces of nitrogen is condensed on the cold surface, the layer will contain small nitrogen particles surrounded by an inert substance. In this state, we should expect nitrogen to behave in a similar way as if the particles existed in free space. Experiments were carried out in mixtures of argon and nitrogen. In one series I used canal rays, in another swift cathode rays; but in all cases I found that the N_1 band became narrower when the concentration of nitrogen became smaller.

At the same time I observed the remarkable fact that *the position of the principal maximum changes with the nitrogen concentration*. For small concentrations the principal maximum approaches a wave-length 5604. Thus with varying composition of the mixture the principal maximum oscillates between the values 5555 and 5604. The "secondary" maxima seem to disappear when the concentration of nitrogen is very small.

The motion of the principal maximum approximately follows the relation

$$\lambda_0 - \lambda_p = \frac{p}{100}(\lambda_0 - \lambda_{100}),$$

where λ_p is the wave-length corresponding to the percentage p of nitrogen and λ_0 and λ_{100} are the limiting positions.

The motion of the band may be due partly to the change of the average size of the nitrogen particles and partly to a mutual influence between argon and nitrogen. Perhaps an X-ray analysis of the crystalline mixture would give some information regarding this point. At any rate, the experiments indicate that a reduction of the size of the particles makes the band sharper, and that the position of the line corresponding to a pseudo-gaseous state need not coincide with any of the maxima observed in ordinary nitrogen under the conditions of my experiments.

The contraction of the bands does not seem to be essentially effected by change of temperature. By working under reduced pressure with liquid hydrogen, the temperature of the layer was lowered from 20° to 14° K.; but there was no contraction of N_1 to be observed, although a change of a few per cent. would have been detected.

The experiments in argon mixtures also give an interesting illustration of the extremely high emission power of solid nitrogen. Even very "pure" argon contained sufficient nitrogen to give a marked emission of N_1 and N_2, and the nitrogen afterglow. The addition

[1] Proc. Roy. Akad. Amsterdam, vol. xxvii. Nos. 1 and 2; NATURE, vol. 113, No. 2846, p. 716; C.R. Acad. Sc. t. 178, p. 1153.

[2] Spectra with larger dispersion were obtained about the middle of March.

of about 0·1 per cent. of nitrogen to the "pure" argon considerably increased the nitrogen effect.

As shown in my earlier communications, slowly moving cathode rays gave in the blue and violet just the same negative and positive band-heads as those typical for the auroral spectrum. The effect has since been photographed with a quartz spectrograph through a quartz window, and the spectrum in the ultraviolet showed the same positive band-heads as those observed in the auroræ.

When the layer is bombarded with a powerful beam of cathode rays from a Wehnelt cathode, a deep red luminosity appears near the layer, and the colour has the same appearance as a red colour very characteristic of the auroræ. A spectrum obtained on a panchromatic plate showed the same two red bands which I have obtained on auroral spectrograms. Thus from the system I am experimenting upon I get the characteristic bands and lines of the auroral spectrum from red to ultraviolet.

Now it is of great importance to see whether also positive rays might give the typical auroral spectrum. For this purpose a considerable number of experiments have been made with canal rays acting on nitrogen, hydrogen, and helium.

Exposed to canal rays, solid nitrogen emitted both N_1 and N_2; but in the blue, violet, and ultraviolet, the canal-ray spectrum was quite different from the typical auroral spectrum. In this spectral region the canal-ray spectrum was dominated by a series of diffuse bands, which extended far into the ultraviolet. Moreover, as has been shown before, the canal-ray spectrum has a number of strong lines not present in the auroral spectrum.

Thus neither in the solid nor in the gaseous state of nitrogen do the canal rays produce the nitrogen spectrum observed in the auroræ, and hence we conclude that by far the greater part of the auroræ must be caused by cathode rays.

Cathode rays which were produced by an induction coil and had a fairly large velocity corresponding to a spark-gap of 5-6 mm. between spheres 1 cm. diameter, gave a very brilliant effect, showing N_1 and N_2 very strongly. Under these conditions I also obtained the same series of diffuse bands as were obtained with canal rays, but their intensities were now relatively smaller.[3]

Nitrogen-argon mixtures were investigated both with canal rays and swift cathode rays, and some results with regard to the variations of N_1 have already been described. Not only N_1, but also the diffuse canal-ray bands in blue and violet, were seen to contract as the concentration of nitrogen became smaller, and at the same time each maximum moved towards shorter wave-lengths. When the layer of argon only contained small quantities of nitrogen, the bands were concentrated into fairly well-defined diffuse lines. In the blue and violet there were two bands, each of which was concentrated into one pair of lines, one pair at $\lambda=4523, 4473$, and the second at $\lambda=4236, 4211$.

These bands are no doubt one state of development of the two bands observed by Lord Rayleigh in the light from the night sky. This means that this light should be produced by fairly slow positive rays.

[3] It remains still to be shown that the bands in blue-ultraviolet are not produced by canal rays, either retrograde rays or rays produced by imperfect rectification of the current.

When the layer of solid nitrogen has been bombarded for some time with canal rays or swift cathode rays the afterglow becomes very persistent. Two or three minutes after the rays are cut off the light intensity from the layer may remain practically constant for hours or perhaps for days. Usually the afterglow only shows the band N_2; but when the persistent afterglow is very strong, I have also observed N_1 and the bands in the blue.

When the liquid hydrogen disappears and the temperature of the layer gradually increases, the stored energy is suddenly released under intense light emission showing N_2 very strongly, but also N_1 and the diffuse bands in the blue appear very strong. Thus N_1 and N and the series of diffuse bands in the blue-ultraviolet are emitted in the afterglow and consequently from the very interior of the solid substance.

When the temperature of the layer increases to a certain point the appearance of the solid nitrogen suddenly changes. At the temperature of liquid hydrogen the layer resembles a piece of ice and sticks to the cold surface; but at a certain point the layer assumes a powdery form, and if it is somewhat thick it falls down from the cold copper surface. The existence of two modifications of solid nitrogen was discovered some years ago by means of cooling curves,[4] and the transformation is found to take place at a temperature of 35·5° K.

Now the energy stored in the afterglow radiates out at the very moment that the layer passes over into the other modification. The phosphorescent energy cannot exist in the modification which is stable above 35·5° K. This phenomenon is explained from the fact that the light given out by the afterglow is characteristic of the modification of solid nitrogen which is stable below 35·5° K., for if nitrogen in the other modification is exposed to cathode or canal rays, N_1, N_2, and the diffuse bands in the blue-violet are not emitted. The luminosity, which is very faint, shows a different spectrum and no afterglow.

This fact has a very important bearing on cosmic phenomena. In that part of the atmosphere where N_1 and N_2 are emitted the temperature must be below 35·5° K., and the isothermal surface 35·5° K. marks the transition between an upper layer very easily excited to light emission and a lower layer which has lost this high emission power.

In this way I think we get the explanation of the fact found by Lindemann that the meteor frequency as a function of altitude shows two maxima with a very marked minimum in between, for below the isothermal surface (35·5°) the meteors may often seem to disappear because they produce very little light until farther down they become luminous on account of heating. Now the height of this isothermal surface ought to be greater in the day than in the night, greater at the equator than at the poles, and greater in the summer than in the winter. Indeed, Lindemann has found that the height of the upper frequency maximum, caused by nitrogen below 35·5° K., increases from 75 km. in the winter to 85 km. in the summer.

The relative intensity of the lines N_1 and N_2 is of importance not only from a physical point of view, but also in connexion with the auroral problem. The

[4] W. H. Keesom and H. Kamerlingh Onnes, Proc. Roy. Akad. Amsterdam, 24, p. 1315.

tisity ratio N_1/N_2 increases generally with velocity the density of the bombarding electric rays, and itrogen-argon mixtures it increases very much when e nitrogen concentration diminishes. With very nl concentrations N_1 predominates as compared with This effect indicates that N_1/N_2 increases as the itogen particles get smaller, and it may thus account rhe predominance of the auroral line 5577 in the ral spectrum.

he great variability of N_1/N_2 makes it difficult to ermine exactly the minimum cathode ray velocity essary for producing the two bands. Perhaps they ire the same velocity, only that the intensity of N_1 usually is very small at small velocities. At the rent time, I have been able to follow N_2 down to cities corresponding to 78 volts, and N_1 down to 6 volts.

non-luminous layer of solid nitrogen was not ile luminous by ultraviolet light from a condensed luminium spark. X-rays, however, produced the rnary afterglow.

When the layer is in the state showing the persistent frglow, conditions are different. In this case light from an ordinary incandescent lamp with a tungsten filament produced a very marked increase in the intensity of the afterglow. In some cases the intensity underwent very marked periodic variations with periods of 5-6 seconds, and I could count 8-9 periods.

Layers of solid oxygen, ammonia, and argon have been bombarded with both cathode rays and canal rays, and a layer of nitrous oxide with canal rays only. With the exception of argon, the light effect was feeble and gave no afterglow. The fairly strong effect observed from an argon layer was to a great extent due to traces of nitrogen, which produced a weak afterglow and a strong emission of N_1 and the canal-ray bands of nitrogen. The afterglow showed only the line N_2 and no other visible light in the spectrum. Thus argon itself gives no afterglow, and the real argon effect, although somewhat stronger, perhaps, than in the case of oxygen ammonia and nitrous oxide, is an effect of the same type as shown by these gases.

The experiments on layers of various substances thus show that the light effect from nitrogen at temperatures below 35·5°, which is applicable to the auroral spectrum, is a light effect of a unique and singular type.

The Beam System of Radio Telegraphy.

THE paper read by Senator Marconi to the Royal Society of Arts on July 2, and published in the Journal of the Society for July 25, describing the results he has obtained over very long distances by short wave directional radio telegraphy, is one of great importance and marks an epoch in the development of long distance radio communication. Mr. Marconi reminds us that more than twenty-eight years ago he showed Sir William Preece the transmission and reception of signals over a distance of nearly two miles by a "beam" system, using short waves and reflectors. Curiously enough, at that time he could only transmit signals by means of an antenna over a distance of half a mile. The rapid and spectacular progress made, however, by the long wave system in those early days diverted attention from short wave research, although the latter could be emitted in beams in definite directions.

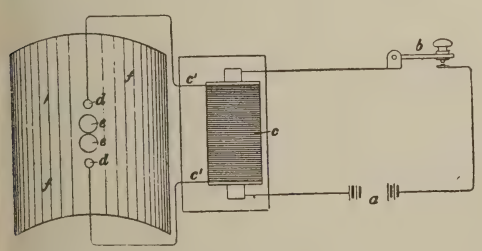

FIG. 1.—Spark transmitter and sheet metal reflector, 1896.

In 1899, Mr. Marconi read a paper to the Institution of Electrical Engineers in which he pointed out that a short wave system would be of value in connexion with lighthouses and lightships in foggy weather, enabling them to locate dangerous points. He also projected a beam of waves across the lecture room, a bell ringing only when the reflector faced the receiver (figs. 1 and 2).

In 1916, in conjunction with Mr. C. S. Franklin, he again began to make researches with directive beams. The reflectors used at first were not solid sheets of metal, but consisted of wires forming a cylindrical parabolic reflector, the antenna forming the focal line of the cylinder (Fig. 3). The reflectors now used consist of a grid of antennæ and a grid of reflecting wires arranged parallel to one another (Fig. 4). Special arrangements have to be made so as to ensure that the phase of the oscillations in all the wires is the same. The great value of reflectors was demonstrated by experiment, the energy received being increased about two hundredfold by their use.

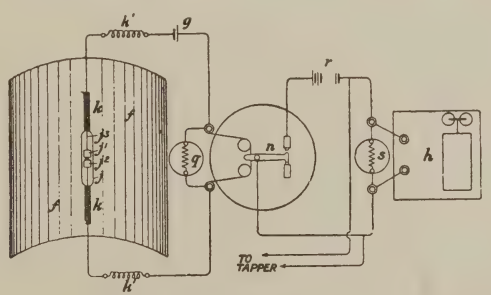

FIG. 2.—Coherer receiver and sheet metal reflector, 1896.

Many tests were carried out between the steam yacht *Elettra* and a small station erected at Poldhu which emitted waves about 100 metres in length, the frequency therefore being about 3,000,000. One definite result obtained was that the strength of the signals received during the hours of daylight varied inversely with the mean altitude of the sun over the space intervening between the two stations. It is wrong, therefore, to refer to distances covered during daylight as "day ranges." It shows also that the tests which were carried out partly within the tropics during the months of May and June were made under very unfavourable conditions.

The results prove quite definitely that the absorption factor given in the well-known Austin formula does not apply to short wave phenomena. It can be replaced by a factor which is approximately a linear function of the mean altitude of the sun calculated on the great circle of the earth which passes through the two stations. In regard to atmospheric disturbances and others, the origin of which is unknown, these appeared to be less troublesome during daylight than when working with a long wave system. During night time, even up to distances of more than 2000

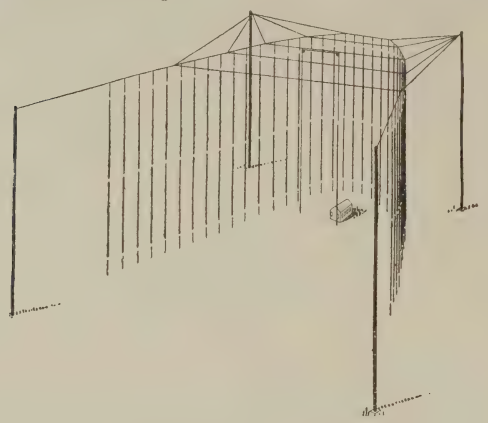

FIG. 3.—Parabolic vertical wire reflector, 1923.

miles, the signals received were so strong that extraneous disturbances caused no appreciable interference.

During the tests, the Poldhu transmitter consisted of eight glass valves in parallel, the input being only 12 kw. The radiated energy concentrated by the parabolic reflector in the direction of Cape Verde was about 9 kw. If no reflector had been used, about 120 kw. would have been necessary to get a beam in that direction of the same intensity. The receiving aerial was a vertical wire at a height of twenty metres above sea-level. The first series of tests was carried out without the transmitting reflector. Day signals were received up to Seville, which is 780 miles from Poldhu, although practically the whole of Spain, consisting of more than 300 miles of high and mountainous country, lay between the sending and the receiving station. At Gibraltar (820 miles), better signals were obtained, as the yacht was anchored in a more open space.

For greater distances the reflector wires were used at Poldhu. At Madeira (1250 miles) good signals were obtained, using 12 kw. at the sending station. At St. Vincent (2230 miles), Cape Verde Islands, it was still possible to get a few hours' daylight reception after sunrise and before sunset. The night signals continued to arrive with apparently unabated strength although the distance had been increased to about double what it was at Madeira.

The strength of the night signals at St. Vincent was estimated to be about 500 microvolts per metre of aerial wire, and no trouble was experienced from any kind of interference. It was calculated that night signals would continue to be received at St. Vinc even if the power at Poldhu were reduced to t tenth of a kilowatt.

After this voyage, the station at Poldhu was i proved, the power being increased to 20 kw. Sir February of this year further tests have been ma A special short wave receiver was installed on t s.s. *Cedric*, and reception tests were carried out wi Poldhu during a journey of the vessel to New Yo and back. No reflectors were used at either en The results obtained confirm the earlier experimen Daylight signals could be received up to a distance 1400 nautical miles.

During this test one surprising result was obtain Mr. E. T. Fisk, of Sydney, Australia, reported by ca that he could receive the Poldhu transmissions p fectly well every day at his house from 5 to 9 P (G.M.T.). He also received them between 6.30 a 8.30 A.M. He used an improvised receiver consisti of a 2-stage high frequency tuned plate and grid wi one rectification. Every word that was sent had be read, and Mr. Fisk stated that the signals were bet than any he had received from the high power stati at Carnarvon. Further experiments on communic ing with Sydney were made, and consistently go results were obtained.

The experimenters conclude that during the morni period the waves start from England to Australia a westerly direction. The waves cross the Atlan and Pacific Oceans, a distance of approximately 12,2 nautical miles. In the evening they travel in easterly direction over Europe and Asia. This is t shortest route, being only 9380 miles.

In Canada, at Montreal, reception was possible sixteen hours out of the twenty-four. A success wireless telephonic test was made with Sydney May 30, the speech being intelligible and easily hea It is noteworthy that this great distance was obtain without the use of a reflector at either end. The

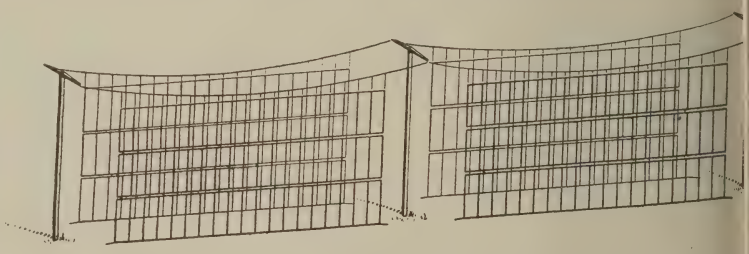

FIG. 4.—Vertical wire flat transmitting aerial and reflector, 1924.

of reflectors would doubtless be a great advanta in practice as it would both strengthen the receiv waves and cut out all the extraneous disturban except any which are proceeding in the line of t beam.

The aerials used were never worked to anythi approaching the limit of their carrying capacity. would be quite possible in practice to superimpo several waves and thus send several services sim taneously from the same aerial. The speed of worki obtainable by using short waves is very much hig than that obtainable by the long waves now in gene use.

Mr. Marconi calculates that the speed of signalling with a 100-metre wave, having a frequency of three million, will probably be a hundred times as great as that obtained with a frequency of 30,000, which is of the order of those that it is proposed to use for the Imperial Stations.

Further tests in June last were made between Poldhu and a small receiving station at Buenos Aires in the Argentine (5820 miles). A parabolic reflector was employed to concentrate the energy in a beam towards the Argentine. Although the power radiated was only 17 kw., strong signals were received for more than ten hours a day at Buenos Aires.

Mr. Marconi is strongly of opinion that by means of these small and inexpensive stations a far greater number of words could be transmitted between England, India, and distant British Dominions than would be possible by means of the previously planned powerful and expensive stations. The communications also would be much more secret than that obtainable by any of the present systems. In conclusion, he expresses his high appreciation of the excellent work done by Mr. C. S. Franklin in this connexion.

Obituary.

Sir George Beilby, F.R.S.

SIR GEORGE BEILBY died on July 31, in his seventy-fourth year, and when he had just laid aside the harness by which he had so long applied his talents with great effect in varied fields. His death caused widespread regret and directed attention to a notable record of public service in the linked relations of science, industries and citizenship. Fortunately for industry his early work brought him into close touch with the details of production as well as with scientific problems which confronted the chemical manufacturer. His skill and thoroughness in investigation, and his clear appreciation of the conditions of large scale work, enabled him to make successive additions of much value to the methods of industry. His relations with commercial production became such that he was in a position to follow up his researches in science by investigation of those of their applications which seemed to be promising. The success which from time to time attended his steady and enthusiastic labour enabled him to give to public purposes much of his energy, as well as to afford substantial support towards the advancement of science and the training of promising recruits for the ranks of scientific workers. Withal, the man and his life will remain in the minds and hearts of many, young and old, as a beacon no less bright than his work.

The son of Dr. G. T. Beilby, a well-known medical practitioner in Edinburgh, Sir George was born there in 1850. He was educated in Edinburgh schools and the University, and he joined the staff of the Oakbank Oil Company as a chemist in 1870. This appointment marked the opening of his professional work, which falls into three periods commencing in 1870, 1890, and 1914 respectively.

1870–1890.—A few years after joining the staff at Oakbank, Beilby became manager, and he held this position until about 1890; thus from 1870 to 1890 his work centred on the Scottish oil industry. He introduced improvements in several sections of the work, the most important being the use of large volumes of superheated steam which was passed into and through the spent shale in the retort, converting the carbon of the shale into water-gas and the nitrogen largely into ammonia. This procedure had several notable advantages, of which the main one was that it more than doubled the yield of ammonia—a result which saved the Scottish oil industry from extinction during the years of severe competition by petroleum.

The minor advantages of the process were: (1) the water gas, formed and heated in the lower part of the retort, conveyed heat internally to the shale in the upper portion, thus assisting to distil the shale at moderate heat; and (2) the removal of carbon from the spent-shale was practically complete, so that fires in the spent-shale "bings" which made these a nuisance in their neighbourhood were avoided. Beilby erected his original retort, operated on these lines, at Oakbank, but later he associated himself with the late Mr. James Young, who was experimenting on similar lines, and together they brought out the "Young and Beilby" retort (patented 1881), which is the prototype of the existing forms.

It is of interest to note that the use of steam in gas production with the purpose of recovering the nitrogen of the coal as ammonia was first proposed by Beilby, who practised it on an industrial scale at Oakbank Oilworks.

Towards the close of the first period of his work Beilby's attention had been attracted by the advent of the McArthur Forrest patents (1887) for the extraction of gold from its ore by means of cyanides. The probable demand for cyanides appeared to him to open an extensive field for chemical industry, and he proceeded to investigate the possibilities of preparing cyanide cheaply. This led shortly to his putting down a small factory near Edinburgh, where he produced the material in fair quantities at a price much lower than that reached by other makers.

1890–1914.—Beilby laid his cyanide process and its results before the directors of the Cassel Gold Extracting Co. of Glasgow (now the Cassel Cyanide Co., Glasgow). His process was accepted, and he became a director and partner in the firm. The process was used exclusively and profitably by this Company until 1900, when Castner introduced a new process for cyanide manufacture, on the development of which Beilby and Castner worked together. The improved process which they worked out was adopted by the Cassel Cyanide Company. At this time Beilby joined the board of directors of the Castner Kellner Alkali Co., Glasgow, and until the outbreak of war he took a leading part in the development of the two companies mentioned.

While this period consolidated Beilby's position as one of the pioneers and leaders of recent progress in chemical industries, it also brought to the front a parallel line of his activities in research—*the using of fuel*—and in this connexion it led to a steady increase

in the proportion of his time devoted to public work. Concurrently with his early work in the development of the recovery of ammonia from shale at relatively low temperatures, he had conducted experiments in steaming bituminous coal. From this onwards he never lost touch with the national problems of prevention of smoke and the economical use of coal. His work on fuel came prominently before the public when he took part in the inquiry of the Royal Commission on Coal Supplies in 1903. He then submitted an analysis of the purposes to which the British output of coal is applied and an estimate of the scope for economy attainable in each category of use by improved methods. His subsequent investigations were at first (1906–1912) directed to the production of a smokeless fuel for domestic purposes. The record of that work, communicated at the 1913 meeting of the British Association, showed that in treating comparatively non-caking coals satisfactory economic results could be obtained. The experiment was, however, discontinued, for the inquiries of the Royal Commission on Fuel and Engines for the Navy, 1912–13, gave a new and wider significance to low-temperature carbonisation. Lord Fisher was chairman of the Commission, and Beilby, as one of its members, could bring to the table not only full knowledge of ascertained fact, effective processes and attained results, but also a ready appreciation of the broad considerations specially relevant to the issues before the Commission. The Commission reported that the only means of rendering Great Britain to some extent self-supporting in the matter of fuel-oils lay in the development of a new carbonising industry founded on the distillation of coal at a temperature much below that used in gas-retorts or coke ovens.

1914–1923.—It was to the problem thus set to British science and British industry that Beilby gave of his best in the last ten years of his life. During the earlier War years his work and his thoughts were much diverted to other issues; but the fuel question was never far off.

When Lord Balfour, then First Lord of the Admiralty, formed the Board of Invention and Research with Lord Fisher as chairman, Beilby was naturally appointed to the Board. It is understood that in much of the great work with which that Board had to deal he proved most fertile in suggestion and wise in consultation and advice. On this section of his public service it may be recalled that in the King's birthday honours list for 1916 he was included among the new knights, being described as "a well-known chemist and inventor, who has specially studied fuel economy, and has rendered service to the Admiralty as a member of the Central Committee of the Board of Invention and Research, and in other ways."

In 1915, when it had been decided to reply in kind to the gas attacks first made by the enemy on the Ypres sector on April 22, 1915, Beilby was sent for by Lord Kitchener, at whose request he arranged that the Castner Kellner Company should provide a supply of liquid chlorine in cylinders. He became a member of the War Office Committee then formed to devise and test materials for offensive chemical warfare. On the formation of the Ministry of Munitions this matter was transferred to the new Ministry. Throughout these years Beilby gave his whole time to work for the Government, mainly in the Trench Warfare Department and its successor, in 1917, the Chemical Warfare Department. Needless to say, the work of the various advisory and supervisory War Research Committees was most strenuous and exacting. Beilby was indefatigable and resourceful always. He was much more. His calm, careful and sympathetic consideration of every intelligent suggestion or criticism were of great value in securing for the service the best use of the talents of the willing and able workers in the field. His individual contributions to scientific investigation of problems arising on appliances for attack or defence were always clear and definite. His guidance on points affecting design with the view of mass production or on suggestions for expediting manufacture was thoroughly practical. The anxieties of the time were many and often sudden. On such occasions Beilby was a great asset. His quiet manner, his refusal to be fussed, the personal sacrifices he made as a matter of course, and his consideration for all who worked with or under him, were of the highest value in the improvised organisations of the time.

But already in 1915 the Government had taken a first step to prepare for attacking the problems which would have to be faced on the advent of peace. A Committee of Council for Scientific and Industrial Research had been constituted, and in 1916 the Department of Scientific and Industrial Research was established, with a strong advisory council of men of science as the central feature in its organisation. Of this council Sir George Beilby was one of the original members. In its first year the council, recognising that fuel was at the root of British industry, advised that the Department should tackle the fuel problem. A year later, despite his other national work, Beilby was prevailed upon to accept the invitation to direct fuel research for the Department, put to him first by Lord Crewe, when Lord President of Council, and again by Lord Curzon when he succeeded to that office. The Fuel Research Board was set up in 1917 with Beilby as its chairman and as Director of Fuel Research.

The burden which Beilby thus took up was a heavy one, and at the initiation of the work he was closely engaged in the war activities indicated above. Moreover, the past strain had pressed him not a little and he had had to undergo an operation for appendicitis. While still feeling the effects of that, he had returned to his war work with his customary energy; indeed his spirit appeared to have carried him through without lasting effects.

The design, construction and equipment of the final Fuel Research Station at East Greenwich were carried through under Beilby's personal supervision, so that the station, its possibilities, its organisation and its staff represent his conception of what is required as the centre of national investigation and research as to fuel production and the using of fuel. The development of the relation of the Fuel Research Board and of its central station to investigations carried out in coalfields and other laboratories had necessarily to wait for more normal conditions, but this, too, had been arranged and initiated before he regarded the organisation as being on a basis so secure that he was justified in demitting the office of Director of Fuel Research.

By the end of 1917, the first year of the work of th Station, the problem set by the Fisher Commission o 1913 had been solved in its scientific and technical a pects sufficiently to permit home production of fuel- c under war-conditions if need had continued to p ss. Commercially it still stands a problem. The n rmal work of the Fuel Research Board has been n ted from time to time in these columns. It therefore s fices here to say that the whole organisation is to all i ents and purposes Sir George Beilby's creation. That e rly result of reference to the Board—the establish- r nt of the method of charging for town gas by the "therm"—is now recognised as one of those little things w ich exercise prevailing influence to the advantage of p oducers and consumers alike.

Sir George Beilby was never without a side interest (a hobby with a scientific bearing. He took a keen interest in colour photography and in microscopy. In the former he made himself expert in the use of the Lumière process in photographing mountain scenery in Switzerland and the Tyrol, and he applied it also in photomicrography. Indeed, some of his photomicrographs, prepared in 1913, were reproduced in a colour-plate published in NATURE of February 19, 1914. Microscopy, from being a hobby, became, and continued, for him a serious study. It was the only method of investigation which he could follow with satisfaction intermittently in casual short intervals in the busy daily life of a busy man. Faced, as a cyanide manufacturer, with the difficulty of finding any metal alloy which would withstand the action of ammonia at 350° C. for any length of time, he turned to the microscope for suggestions as to the conditions of the problem.

From this Beilby was led to investigate the effects of various forms of mechanical work on the crystalline structure of metals, for example, the disturbances which occur in the processes of polishing and burnishing. As usual he spared no pains in making himself a master of the technique of the methods which he employed to study his subject from every angle. He made an experimental study of a number of solids in various states of aggregation. His researches in this field, which were ingeniously planned and most accurately carried out, were of an entirely novel kind. He gave an account of this work in the May lecture which he delivered to the Institute of Metals in 1911. In his book, "The Aggregation and Flow of Solids," 1921, he published collected statements of his work on this subject, including his more recent investigations. The facts he recorded are those which he established by most careful work and observation repeated time and again. These and the theory of the hard and soft states of metals which he put forward in 1911 had a profound influence for several years on the development of metallography, and gave rise to a variety of researches designed to test the range of application of his theory. In view of recent researches on the constitution of matter it is difficult to judge the precise form of the theory which will ultimately be accepted, but there can be no two opinions as to the magnitude of the service he rendered to the elucidation of the changes produced in metal crystals by mechanical work of all kinds.

As a citizen—indeed in all relations—Beilby systematically shunned publicity. Even in matters of public interest for which he did active work, his help was so unobtrusive that it was little known unless circumstances made his emergence unavoidable. Education, training for and in research, smoke prevention, each succeeded in identifying him, but these were by no means the limits of his active help in affairs. In 1877 Sir George married Emma, daughter of the Rev. S. Newnham, and Lady Beilby has been a devoted coadjutor in many of his public interests. With her he was early among those who worked for the admission of women to professions, and this cause appealed to him in the first instance in the critical case of medicine. Their interest in students, particularly students of science, began many years ago, and only few have even a general idea of the extent to which he coupled financial help with advice as to courses of training or subsequent experience. Sir George was one of the trustees of the Carnegie Trust for the Universities of Scotland, and he took a keen interest in the details of the work of that Trust. He was a fellow of the Royal Society, and one of the first members of the executive of the National Physical Laboratory formed by the Society in 1900 with Lord Rayleigh as chairman.

It was, however, the Glasgow and West of Scotland Technical College—now the Royal Technical College—which indented most fully on his ready help in council. He was co-opted as a governor of the college in 1900, and on the Board of Governors his wide knowledge of men of science and of industry soon commanded the confidence of his fellow-governors, and his foresight did much to secure that the building then being planned was conceived on an adequate scale. In 1903 he became convener of the sectional committee on the departments of chemistry, technical chemistry and metallurgy. The scheme of teaching and the nature of the laboratory courses and appliances adopted were novel at the time, but have since proved applicable in other places. In 1907, on the death of Sir William Copland just when he had completed the task of raising funds for the erection of the new buildings for the college, Sir George Beilby was elected chairman of the governing body.

The new buildings and equipment secure, the governors and staff strove strenuously, and with success, to raise the standard reached in the college teaching and to develop the training of promising students in methods of research bearing on industries. In 1913 the college was affiliated with the University of Glasgow and was included among the institutions recognised for grants by the University Grants Committee. The raising of the college ideals and the effective efforts towards improvement of practice were largely due to the all-prevailing influence and wise initiative of the chairman. His fine personality was a great asset in every development of the college and its work.

One example of this may now be mentioned. Sir George had been providing funds year after year to enable good men to remain at college for training in research methods for a year or more after completing their ordinary courses. When the results of this encouragement had become amply apparent he set about placing this help and cognate facilities on a

permanent footing. A "New Development Fund" was established and started by an anonymous contribution of 10,000*l*. Sir George was the donor. He was one of those who knew how to use money to good purpose. The fund was well opened, and although the war years checked its growth it now amounts to 65,000*l*.

Sir George Beilby's fine personality was a great asset in every development of the Royal Technical College and of its work. His touch with students was, however, of long standing and it was real, informal and elevating. His house in Glasgow was for years a place of resort for young men. Music had a home there—Sir George himself was an artist in music; he was also a first-class craftsman; he built his own organ, buying only the pipes, and much of the refinement of its mechanism was of his own invention. Conversation there on current topics never flagged in interest although it often strayed. Personal talk or counsel on individual aims or on difficulties over study always refreshed the visitor.

In our world of to-day—its science, its industries and its humanities—Sir George Beilby has been a notable exemplar of the "veray parfit gentil knight."

We regret to announce the following deaths:

Sir William Bayliss, F.R.S., professor of general physiology in University College, London, on August 27, aged sixty-four.

Dr. John J. Stevenson, professor emeritus of geology at New York University and president in 1899 of the Geological Society of America, on August 10, aged eighty-two.

Current Topics and Events.

The recent conference at Oxford on "The Scientific Approach to Religion" was a notable event and aroused a good deal of interest in the Press and the public. The change of tone is amazing since the famous Diocesan Conference at Oxford in 1864, when Disraeli strolled in and declared himself on the side of the angels and not of Darwin. Of course the battle had been won long before this, but it was well that Oxford should be the scene of so striking a reconciliation after the half-century. The notes struck were, the abandonment of final and exclusive dogmas either on the side of science or of religion, and the possibility of a man of science being a theist and Christian, and of the "religious" person accepting all or any of the established conclusions of science. We imagine that nowadays few people will be found to dispute any of these propositions. We all agree in general terms; the difficulties arise when we come to define them. This could be illustrated from almost any of the papers read. For example, Dr. Rollin stated that the point of the theists had been demonstrated that the world in its essence was a form of energy, and energy, so far as all our knowledge went, did not come from nowhere. But would such a doctrine satisfy any theist who thought out carefully what he meant, or would it have convinced Ostwald that he was a theist? The fact is that such an eirenicon as was proclaimed last week in Oxford is rather testimony of general goodwill, of a change of temper, and of a readiness to examine, than of definite agreement as to really disputable points. For what it was, we heartily welcome it and would not add a word to hinder so healthy a process. We need above all to strengthen the bases of our intellectual and social amity, but let us make sure of the strength of the stones we lay. It would be a disaster if they crumbled into sand when we began to raise the superstructure.

At a recent meeting of the Wiltshire Archæological Society a discussion took place with reference to permission having been granted to a modern sect styling themselves "Druids" or "Church of the Universal Bond," who contemplate burying the ashes of their dead within the precincts of Stonehenge. The discussion was followed by a strong protest against this unseemly intrusion. It is only a few years since this well-known monument was handed over to the nation by a generous donor, and as it came thereby under the protection of H.M. Office of Works, it was hoped that this would effectually stop desecration and any future trouble. A question in the House of Commons regarding a rumour of the proposed burial of ashes, put by the member for the Salisbury Division to the First Commissioner of Works, elicited the reply that permission had actually been given. Apparently the Commissioner had been approached by the sect privately and gave the desired permission on his own initiative without consulting the Advisory Board or taking thought what the result might be. This deplorable attempt at vandalism is strongly resented in the County and by the public generally, who hold in reverence the mighty monument set up by our progenitors. The members of the "Church of the Universal Bond" have camped for a fortnight annually upon the downland about half a mile from Stonehenge, and the Office of Works, despite suffering irritation from them, generously gave permission for services to be held within Stonehenge. Instead of being grateful for this boon an insulting letter was sent in reply, asserting that the place belonged to the sect, and no advantage was taken of the concession. Apparently an attempt is now being made to secure a hold upon the place, and this move should be resisted vigorously and to the utmost by every one who has a regard for Stonehenge. It is ridiculous to think of a small and obscure set of people having the impertinence to arrogate a claim to this National Monument. With just as much reason another sect might arise calling themselves "Romans" and laying claim to Roman villas.

Spain is a country rich in archæological remains, and many are the investigators who have made notable discoveries there. English readers have been hearing from time to time about the work of Mrs. Wishaw and the founding of the Anglo-Spanish School of Archæology at Niebla, Huelva, in Andalusia. A long article on her discoveries appeared in the *Times* of August 23, and we have received the following note upon it from a contributor, M. C. B.:—Mrs. Wishaw's

vestigations cover a rich and interesting field of Roman remains, including waterworks, etc., which is not dealt with in the article. Next, many finds have been made dating back to pre-Roman (Iberian) times. These discoveries include objects of pottery, etc., many of them exceedingly important. It is perhaps a pity that Mrs. Wishaw has not concentrated on these two fields where such valuable finds can be made, and where she has already done work of undoubted service to the archæologist. Her chief interest and object, however, seems to be to demonstrate that Upper Palæolithic man flourished at Niebla, even arriving at the stage of building walls and making pottery, and the recent article is largely devoted to this subject. Although the writer has not yet had occasion to visit the Niebla site itself, he has had the opportunity of seeing some examples of the stone industries, and he can only unhesitatingly suggest that, unless there is something further to show, nothing is as yet advanced which in the least proves the occurrence of Palæolithic man there. The specimens seen were, in his opinion, at earliest no older than the Neolithic Age. It is to be hoped that Mrs. Wishaw will continue her work, more especially of the later cultures. Spain possesses the advantage of having in the person of Dr. Obermaier, of the University of Madrid, one of the most brilliant of European prehistorians, and he would undoubtedly be willing to help at any time in dating the finds.

On August 25 a report, unsupported by details, appeared in various newspapers to the effect that 4 inches of rain had fallen in six hours at Cannington, Somerset, during a "cloudburst." It has since been ascertained that 9·04 inches were measured at Crymore, one mile west of Cannington, at 9 A.M. on August 19. The observer estimated that, of this amount, 8·5 inches of rain and hail fell between 1 A.M. and 7·30 A.M. on this date. At the Bridgwater Water Works, Ashford, about one mile from the Cannington gauge, 4·50 inches were measured. Further particulars with regard to this downpour will be awaited with interest, and some suspension of judgment is necessary until the measurement has been finally confirmed. A fall of eight and a half inches at an average rate approaching two inches an hour is quite unprecedented in the British Isles, though this rate has of course been frequently exceeded in short periods. The total amount of 9·04 inches has only been exceeded on one previous occasion, namely at Bruton, Somerset, on June 28, 1917, when 9·56 inches fell. During the climax of that disturbance the rate of fall reached one inch per hour for two hours. A similar rate was observed in the great East Anglian rain of August 25-26, 1912. On the day of the recent "cloudburst," a depression was stationary over the northern part of the North Sea and shallow secondary disturbances were passing over the British Isles. The conditions were favourable for heavy local showers of a thundery character. No large amounts of rain were, however, measured at health resorts or Meteorological Office telegraphic reporting stations in south-west England. At Weston-super-Mare, the nearest station the observations of which are telegraphed to the Meteorological Office, the total fall for the twenty-four hours ending at 9 A.M. on August 19 was only 7 mm. (0·28 inch).

The Royal Society of Western Australia, as part of the commemoration of the Kelvin centenary, has instituted the award of a gold medal for research. The medal will ordinarily be awarded every four years, and the first recipient is Dr. William J. Hancock. This is awarded in recognition of the part which Dr. Hancock has played in the development of radiography and radiotherapy in Australia since the discovery of X-rays. Until recently Dr. Hancock was the Government Electrical Engineer and is an honorary member of the Institution of Engineers of Australia. Those who took up the practice of X-rays soon after their discovery had many difficulties to overcome, and for a long time their pioneer work entailed real scientific investigation, the results of which rarely found their way into print. Nevertheless, it was largely due to these men who began to apply X-rays for medical purposes that the technique has evolved on the present lines. Unfortunately, few of these pioneers escaped injury from the rays they were using, and we regret to learn that Dr. Hancock is not an exception in this respect.

In the Faraday lecture of the Chemical Society, which has appeared in the July issue of the Society's journal, Prof. R. A. Millikan devoted attention to certain aspects of atomic structure which are receiving particular attention at the present time, especially from the spectroscopists. As a preliminary he insisted upon the very definite nature of the proof we now possess of the existence of the electron, citing in this connexion his own famous experiments with the oil drop, which the latest researches in his laboratory have rounded off in a very convincing manner. Then, after summarising our knowledge of the nucleus atom, and emphasising the success of the orbit theory as worked out by Bohr and his followers, in particular Sommerfeld, he proceeded to describe briefly some recent experiments carried out by himself in collaboration with Mr. I. S. Bowen. Working with the so-called hot spark, in extreme vacua, these investigators have succeeded in obtaining spectra emitted by atoms which have, in extreme cases, lost as many as six of their "outer" electrons. In the first group of the periodic table they find evidence for the existence of "stripped" atoms, *i.e.* atoms which have lost all their outer electrons, of all the elements from lithium to nitrogen, the last-named having, of course, lost five electrons: in the second group they have obtained stripped atoms of all the elements from sodium to sulphur, which involves a loss of six electrons in the last-named. This constitutes a notable extension of the work of Prof. A. Fowler and of Prof. Paschen, who have obtained respectively the spectra of doubly and trebly ionised silicon, and of doubly ionised aluminium. For the identification of the lines, Prof. Millikan has derived much support from the increase of doublet separation with nuclear charge, which agrees well with the Sommerfeld relativity formula applied to his assumptions. Further consideration of his results has led

Prof. Millikan to conclude that the electrons possess inverse-square-law fields of force at orbital distances. The detailed account of this work has not yet been published, and will be awaited with keen interest by all physicists. It may be noted that Prof. Millikan comments unfavourably on the static atom, which he calls the "loafer electron theory," to express in brief the conception of "electrons sitting around on dry goods boxes at every corner, ready to shake hands with, or hold on to, similar loafer electrons in other atoms." He also objects to the term "proton," preferring "positive electron."

PROF. FREDERICK SODDY, professor of chemistry in the University of Oxford, has been elected a foreign member of the Reale Accademia Nazionale dei Lincei of Rome.

PROF. A. S. EDDINGTON, Plumian professor of astronomy and experimental philosophy in the University of Cambridge, has been elected an honorary member of the American Astronomical Society.

IT is stated in the *Times* that a French pilot, Lieutenant Thoret, has made a record gliding flight at the aerodrome of Les Alpilles, near St. Rémy-en-Provence. He remained in the air with the engine of his machine stopped for 9 hr. 8 min. The previous record was held by a German airman, who was in the air for 8 hr. 42 min.

FOR the past year, Dr. J. J. Simpson, Keeper of Zoology in the National Museum of Wales, Cardiff, has given a weekly chat on some natural history subject from the British Broadcasting Company's studio in Cardiff. He has dealt in one series with British mammals, and these are to be published shortly in book form by the Sheldon Press. He has now started a new series on "Romances of Natural History," and has already dealt with "The Eel," "Aquaria," "Sticklebacks," "The Honey Bee," "The Tadpole," "Our British Reptiles and Amphibians, etc.," and will, during the next few weeks, talk on "The Mayfly," "The Sponge," "The Salmon," "The Lamprey," etc. It is noteworthy that the Cardiff station was the first to inaugurate a series of such talks, and from the correspondence received it is evident that they are stimulating a wide interest in natural history. It was inevitable that such would be the case, because the various subjects are dealt with in non-technical language, and must appeal to a large public both juvenile and adult.

MR. F. EDWARDS, 83 High Street, Marylebone, W.1, has just circulated Catalogue No. 461 (British Empire Series, No. 4), containing particulars of nearly 800 books, engravings, and drawings relating to Africa. Copies are obtainable from the publisher upon request.

THE autumn announcement list of Messrs. Edward Arnold and Co. contains two memoirs which should appeal to readers of NATURE, namely, "The Life of John William Strutt, Third Baron Rayleigh, O.M.," by his son, the present Lord Rayleigh, and "Huia Onslow," by his widow, Muriel Onslow. Lord Rayleigh over a long period was a frequent contributor to NATURE, and a short series of articles on "The Iridescent Colours of Insects" by Mr. Onslow appeared in our columns not long before his death.

AMONG the autumn announcements of Messrs. Longmans and Co. is a book by Prof. S. J. Hickson entitled "An Introduction to the Study of Recent Corals," in which attention will be given to the structure by which corals capture and digest their food, the colours they display in life, and the means by which they propagate their kind. A descriptive of the structure of the soft parts of the coral and of its appearance when alive will be given wherever possible in the description of the genera.

ERRATUM.—In issue of August 30, p. 302, col. line 32, for "as well as the study of science, that letters" read "the study of science, as well as that of letters."

Our Astronomical Column.

ENCKE'S COMET.—This comet was of magnitude 14 at the end of July, but it has been rapidly approaching both sun and earth, and should now be visible with ordinary telescopes, especially before September 10, as the moon will be troublesome after that date. The following ephemeris, for Greenwich midnight, is from the B.A.A. Handbook:

	R.A.	N. Decl.	log r.	log Δ.
Sept. 5.	5h. 53·0m.	36° 46′	0·0845	9·9948
9.	6 21·4	37 10	0·0621	9·9670
13.	6 53·2	37 7	0·0378	9·9406
17.	7 28·2	36 28	0·0113	9·9170

The comet is nearest to the earth on September 30, and to the sun on October 31. It is due south about 7 A.M., but from its high northern declination it is observable in the east shortly after midnight. On September 5 it is near θ Aurigæ, on September 17 some 4° north of Castor. It should be followed until about October 20, after which it is inconveniently near the sun, and rapidly moving south.

ABSORPTION IN THE ATMOSPHERE.—M. J. Baillaud describes, in the *Comptes rendus* of the Paris Academy of Sciences, May 26, observations on the coefficients of transmission of light of different wave-lengths by the atmosphere, made at the Pic du Midi Observatory. A curve resulted, more or less parallel to that obtained by Rosenberg at Göttingen, but with somewhat higher values, and agreeing still better with that of Abbott and Fowle taken at Mount Wilson. On October 21, 1921, however, the values for small wave-lengths, about 380 mμ, were abnormally small, the curve running into the normal curve for longer wave-lengths. It was noticed that, although the sky was very clear, hoar frost was deposited on the outside wall of the observatory, and it is suggested that there may be a special absorption band for water vapour which has not as yet been observed in the laboratory when it is in the unstable state which precedes condensation. In support of this hypothesis, the observation of Nichols and Pacini, that the short wave-lengths are weaker in proportion to the long ones in light from clouds than in that from the clear sky, is brought forward. It does not seem possible that the abnormal absorption was due to ozone, as the amount of this gas required to produce the effect would be some seventeen times larger than that normally existing in the atmosphere.

Research Items.

THE DISTRIBUTION OF CALAMITIES.—Four months ago attention was directed in these columns (vol. 113, p. 653) to a proposal to study the distribution of calamities such as earthquakes, epidemics, floods, etc., under the auspices of the International Red Cross Committee and of the League of Red Cross Societies. A chief feature of this proposal was the issue of a quarterly review, *Matériaux pour l'étude des calamités*, to be edited by M. Raoul Montandon. We have now received the first number of this journal containing articles by the editor on the geography of calamities, and by M. Louis de Launay on earthquakes and volcanoes, as well as notices of memoirs bearing on the subject. The main object of the movement is the relief of suffering among populations affected by great calamities, and the editor urges that a useful preliminary step in the organisation of relief would be the publication of an atlas of the world showing clearly the site and extent of all catastrophes.

ACTIVE PHILIPPINE VOLCANOES.—The Bulletin for April 1922, recently published, in 1924, with the authority of the Government of the Philippine Islands, contains an article on the above prepared under the direction of Rev. José Algué, S.J., Director of the Weather Bureau of the Manila Central Observatory. Data relative to the Philippine volcanoes were previously published in 1901 and 1903. Since then volcanic events have been described in the Bulletins of the Weather Bureau, and observations of particular volcanoes were undertaken chiefly by the geologists of the Bureau of Science. The author mentions that the Apo and Sarangani extinct volcanic chain is in line with the Sanguire group, which is still active, being about 200 kilometres south of Sarangani, across the north-east part of Celebes Sea. A prominent peak or cone of the Apo group is Matutum; this is a very old volcano, its local name Matutum meaning "has burnt" or "fire out." With reference to the group Makaturing and Ragang, the author is inclined to believe that all the historic eruptions attributed to the former occurred in the latter. Dealing with volcanoes on Luzon Island, especial reference is made to Taal volcano, said to be probably the lowest in the world. It rises in the centre of Lake Bombon, at 14° 2′ N., 120° 57′ E.; the altitude of the lake is less than a metre above sea-level, and the highest wall of the crater is about 300 metres. The last eruption occurred in 1911 and annihilated everything around within a radius of several kilometres, causing about 1300 deaths.

CURRENT METER RATING.—The rating of a current meter for recording the discharge of streams is, of course, an important procedure, and every care is essential in order that the rating shall be carried out under conditions approximating as closely as possible to those obtaining in the actual observations. The customary method of calibrating a meter is to draw it through still water at known speeds, simultaneously observing the corresponding speeds of the rotor. The objection has been raised that this is merely a record of parallel and uniform stream line flow, taking no account of variations in the speed and direction of the filaments of water characteristic of ordinary river discharge. Such variations are generally grouped under the designation of turbulence. In NATURE of June 14, p. 872, we referred to a turbulence gauge designed by Mr. B. H. Wade of the Egyptian Ministry of Public Works to record the effects of turbulence in connexion with the computation of discharge in the river Nile. We have now received a copy of Physical Department Paper, No. 14, issued by the same service, in which Dr. P. Phillips discusses certain experiments which he has made on the rating of current meters by means of a new rating apparatus, brought into use at Abbassiya Water Works, by which the three essential observations (time, revolution of rotor, travel of carriage) are recorded automatically, so eliminating personal errors. This apparatus has been found to give results agreeing closely with the makers' average rating curve, and with the rating of the United States Bureau of Standards. It records a smaller number of revolutions per minute for the same velocity than does the old apparatus at Giza, the difference ranging between 2 and 5½ per cent. for different velocities. The new apparatus is explained with the aid of diagrams and photographs.

IMPLANTATION OF THE HUMAN OVUM.—Prof. J. H. Teacher has contributed to the summer number of the *Journal of Obstetrics and Gynæcology* (vol. 31, No. 2) an important paper on the implantation of the ovum and the early development of the trophoblast in man. That the human ovum burrows into the uterine mucous membrane, parasite-like, destroying tissue and provoking inflammatory and reparative reactions, has been recognised for some years. This memoir contains an account of the further discovery that the closure of the decidua reflexa is effected by an apparatus developed from those ectoderm cells of the ovum which are the last to enter the mucosa tissue. This apparatus unites with the uterine epithelium and afterwards with the other tissue of the lips of the aperture through which the ovum has passed. For the complete structure the author suggests the term "operculum deciduæ." The recognition of this apparatus has led to the identification in the human ovum of a polar arrangement similar to that found in the hedgehog and in the guinea-pig. The ovum, therefore, may be described as having an entering or implantation pole and an adhering or closing pole, and it is this polarity which determines the position of the embryonic rudiment in the blastocyst and the situation of the placenta. The operculum, which differs from the Traeger of the rodent in taking no part in the formation of the placenta, usually becomes detached from the blastocyst when its function of closing the aperture has been fulfilled, a shield of fibrin being formed by thrombosis in the implantation cavity and so closing the passage from within. Prof. Teacher finds that the conclusion formerly arrived at by himself and Prof. Bryce that there are two generations of trophoblast (a primitive or implantation and a placental trophoblast) is entirely justified. These and many other cognate matters are dealt with in this memoir. It is illustrated by fifteen magnificent plates (some coloured), the cost of which has been defrayed by the Carnegie Trust for the Universities of Scotland. The material used in the investigation consisted of the original "Teacher-Bryce" ovum, first described in 1908, and a new human ovum of somewhat later age. The recent literature of the subject containing accounts of other early ova is referred to so as to facilitate a comparative study of the various processes described.

DIFFUSION AS A FACTOR IN ORE DEPOSITION.—In a paper on "Some problems of diffusion, with special reference to the study of ore deposits" (Science Reports of the Tohoku Imperial University, 3rd Series, vol. 2, Nos. 1 and 2, pp. 105-185), Manjirô Watanabé gives the results of some investigations on diffusion, amplifying the work done previously by Liesegang and others, but giving special attention to

the bearing of diffusion phenomena on ore genesis. Following Liesegang's method, experiments were made with gelatin media. Experiments were made also with kaolin, sand and calcium carbonate, in order to approximate more closely to natural conditions of ore deposition. As reacting materials, the sulphates, carbonates, nitrates and chlorides of common metals, sodium and barium sulphides, ammonia, and sodium carbonate or bicarbonate were employed. The velocity of diffusion with simultaneous precipitation was investigated, and a new equation proposed for the expression of diffusion velocity under these conditions. This equation is $x/\sqrt{z} = K(Z-z)/Z$, where z is the time and x the distance of diffusion, Z the time from the commencement of diffusion to the critical point of precipitation, and K is the velocity coefficient or the value of $x/\sqrt{z}$ at the commencement of diffusion. An examination of the magnitude of diffusion effects in Nature led to inconclusive results, but it is inferred that, contrary to the claim made by some previous workers, the effect of increased temperature in promoting diffusion is comparatively small; and that it takes more than 10,000 years for diffusion to take place over a distance of 100 metres. Other problems investigated include rhythmic precipitation, zonal or differential precipitation, and the action of various solutions diffusing into colloidal precipitates of metallic compounds. The order of stability of various sulphides in acid solutions, from more stable to less stable, was found to be as follows: silver sulphide, copper sulphide, lead sulphide, zinc sulphide and ferric sulphide.

The Economic Utilisation of Coal.—In the June number of *State Technology*, the journal of the Institute of Professional Civil Servants, Mr. H. E. Weaver has an article on coal, directing attention in simple language to facts long recognised by fuel experts but little appreciated by the general public: that this commodity is an ever-wasting national asset and that its combustion in open grates is little short of calamitous. The proper utilisation of coal lies in its scientific carbonisation, the refinement of its many and varied products, as in the case of petroleum, and their economic use under the best conditions in national, industrial, and domestic life. To a large extent the coal-gas industry has pointed the way, and there is little doubt that its development to its present important position is due not so much to the actual production of gas as a common form of heat energy, as to the numerous and invaluable by-products to which its preparation gives rise. As is well known, the products resulting from retorting coal can, apart from the gases evolved, be grouped into two main classes—tar and ammoniacal liquor; the former is the basis of a wide range of oils, including anthracene, themselves the starting-points for the production of benzol, naphthalene, cresols, creosote, anthracene, to mention only a few compounds; linked up to the refinement of these products are a host of distinctive technical processes resulting in the manufacture of motor fuel, explosives, disinfectants, preservatives, drugs, and perfumes (mainly from treating benzol, toluol or xylol), the production of dyes from naphthalene, with alizarine and further dyes from anthracene; the solid products in the form of pitch and other hydrocarbons are likewise capable of refinement for the particular purposes to which they are to be put. From the ammoniacal liquor are prepared the valued ammonium salts and ammonia itself, cyanides, and sulphur compounds. One has only to remember the significance of cyanide in the South African gold industry to realise its importance as a factor which has made that industry possible. There is, in effect, such a wealth of possibility in the lumps of coal which we casually put on our domestic fires, that our action must seem little short of desecration to the "spirit of coal," cleverly portrayed on the posters issued by the Gas Exhibit Committee at the British Empire Exhibition, to which, and also to the instructive gas exhibit, the author rightly directs public attention.

The Production of High-Velocity β-rays by the Action of Hard β-rays—M. J. Thibaud has studied the β-rays produced by bombarding U, Pb, W, and Ag with the high-energy γ-rays of RaC (*C.R.* Paris Acad. Sci., July 21). The following table gives in the first line the symbol of the element employed as secondary radiator, in the second the energy in kilovolts required to detach an electron from the K level, and in the following the energies in kilovolts of the observed β-rays.

U.	Pb.	W.	Ag.
117	89·3	69·5	25·6
1004	1034	1057	1100
1122	1151		
1650	1677		

When the energies in the first line are added to those in the following lines, the energies of the γ-rays liberating the β-rays are found to be 1123, 1241, and 1763 in kilovolts; a γ-ray with energy 605 kilovolts has been previously found. All the important lines of the high-velocity β-ray spectrum of RaC, with one exception, are due to a photo-electric effect of the penetrating large quantum γ-rays. When radium is in contact with another element, there are two corpuscular emissions, giving similar spectra more or less shifted with regard to one another, the first being about four times as intense as the second. This agrees with the view of Ellis that the atom emitting the γ-ray has the greatest probability of absorbing it, and producing photo-electrons.

Conductivity of Metallic Vapours.—Work has been done on the conductivity of metallic vapours in flames by a number of investigators, but Dr. E. Zachmann, in the July number of the *Annalen der Physik*, shows that a number of precautions which are necessary in order to measure the true conductivity have previously been neglected. He develops the theory and describes a very complete investigation of the vapours of the alkali metals. Two devices were adopted to prevent electrons from heated electrodes from penetrating into the flame; the hot surface of the Meker burner employed was made the anode, and electrons from it were driven back into it by the applied E.M.F.; the cathode stood above this, and was divided into a central portion of copper with a circular horizontal surface, surrounded by the horizontal surface of a metallic grid, which formed a guard ring; both portions of the cathode were water cooled. It was possible to adjust the flame so that, over a considerable vertical length, it could be shown that the field intensity was nearly constant. The probe electrodes employed were investigated theoretically and experimentally, and the best form for them was determined. It was found that the conductivity of the vapours of the alkali metals is proportional to the square root of the concentration in the flame, which agrees with the theory; it varies as the square root of the atomic weight of the metal, and increases rapidly with increase of temperature. It also appears that the production of electrons is almost entirely due to collisions between the metal atoms and the gas molecules of the flame, very few being due to collisions between two metal atoms.

Recent Industrial Research in Cotton.[1]

THE volume of memoirs before us includes eight summaries of the current literature on such properties of cotton and cotton materials as are studied in more detail in the majority of the twenty-three other original papers. Although the plant is the source of supply of raw cotton, it is strange that these memoirs contain only one summary of existing literature on the application of botanical knowledge to immediate cotton industrial needs. The reason is that little trustworthy literature on this important subject exists.

The summaries are well compiled, and the length of the appended bibliographies (one includes 200 references) illustrates the care taken in their production. They are invaluable to scientific workers, in cotton and other allied textile materials, who are outside the British Cotton Industry Research Association.

The original papers are contributions from the botanical, physical, chemical, and physico-chemical departments of the Shirley Institute. Papers on the measurable characters of raw cotton, the morphology of the cell-wall of the cotton hair—which embodies some excellent photo-micrographs—and the conditions causing, and the prevention of, mildew in certain dyed cloths, form the bulk of the contribution from the botanical side. It is stated that infection of a cloth with a moisture content of 7·8 per cent. developed in nine weeks. Since raw cotton will absorb this quantity of moisture on exposure to an atmosphere of 0·66 relative humidity, which is far below the average value for the Lancashire district, the oft-recurring appearance of mildew in the raw material is not surprising.

The physical papers on the behaviour of cotton yarns under alternating stresses are characterised by the enormous number of tests made. Periodic variations which have previously been established in yarns tested by continuous loading methods, are found, in many cases, either to have disappeared or to have been considerably modified. Also, as neither of the two methods of testing is directly applicable to the study of stress effects in cloth, it is very doubtful whether, at this stage, the results obtained from thousands of tests on the peculiarity of any one yarn, very often the product of poor workmanship or the effect of efforts to increase production in the mill, are worth the highly trained labour expended on them. The writer is well aware of the variability of yarns spun under the best conditions, but cannot this be paralleled in the large scatter of rounds about a target engaged by a gun well and truly laid? A good gunner knows well that a comparatively long bracket is sufficient information to enable him to register the target roughly, if many other targets are to be registered in a limited time. Later, the interesting targets are then given the further attention which appears to be adequate.

The physical papers on the rigidity and plasticity of cotton hairs are very carefully done. It is doubtful whether the determination in absolute units of the coefficient of rigidity of a cotton hair, with its characteristically open structure, can be justified, especially when the influence of the relative humidity of the atmosphere on the physical constants of the hair is almost ignored. The force required to bend a dry cotton hair is greater than the force to bend the same hair containing 20·0 per cent. of moisture, even though the wet hair has the greater cross-section. The work on the plasticity of cotton hairs is of much higher order, and the magnetic torsiometer employed in this investigation is a cleverly designed instrument, well suited to the continuous measurement of small forces.

Two good methods of measuring the lustre of doubled yarns are described. The first is a direct photographic, and the second a photometric, method, in which the intensity of the light reflected from the yarn is compared with the intensity of light transmitted through a ground glass screen, illuminated in a controlled manner. A satisfactory method of measuring the lustre of yarns has been much needed, and the definiteness of the results obtained with the photometric method is encouraging. The general utility of the investigation is marred by the absence of information on the mercerising process used in preparing the yarn, on which process the lustre of yarns so much depends.

The investigations on the chemical constituents of the benzene extract from American cotton, and the volatile products derived from cotton by the action of water and sodium hydroxide at 40 lb. pressure, almost lead one to ask whether there is anything which cotton does not contain. The detailed examination of the extracts reveals the skill and patient labour involved.

Braidy's method of determining the copper number of modified and unmodified cotton cellulose has been found satisfactory after critical examination. The application of the results of colorimetric and titrimetric methods of determining the quantitative absorption of methylene blue by cotton cellulose of varying purity to the control of the bleaching process, to the detection of oxidation of cellulose (over-bleaching), and to the distinction between some raw Egyptian and American cottons, is perhaps the most interesting of the chemical contributions. The absorption of methylene blue by cotton cellulose is shown to vary directly with the ash content, thus confirming the conclusions of Rona and Michaelis and opposing the views of Bayliss.

On the physico-chemical side, work on the properties of starches used in sizing yarns is described. The results of the investigation on the moisture-absorbing properties of thin films of cooked starch bear a striking resemblance to those obtained on the moisture-absorbing properties of cotton. The botanical origin of the starch is found to have no appreciable bearing on the moisture-absorbing power. In contradistinction to this, the viscous properties of pastes made from maize and farina starches are shown to differ considerably.

Using a more sensitive form of the Justin-Mueller turgometer, the swelling of cotton cellulose in sodium hydroxide solutions has been examined. Although this attempt to find a means of eliminating discrepancies due to differences in the visible structure of cotton hairs was not successful, some interesting structural changes are noted.

Although these memoirs are an encyclopædia of information on the measurable properties of raw, spun, and chemically treated cotton, there is comparatively little cross-connexion or generalisation. They might be compared favourably with a Greek temple in the first stages of construction. The foundations have been thoroughly explored, and a number of pillars have been begun at very short spacial intervals. We are hopeful that the superstructure will be worthy of the stoutness of the supports; meanwhile, those who are only interested in the commercial value of the knowledge can trust in this solidity until such time as the superstructure takes a form which they can recognise. F. P. S.

[1] Shirley Institute Memoirs, vol. 2, 1923. Pp. vi+394+v. (Manchester: British Cotton Industry Research Association, 1924.) n.p.

Orchard Heating in the United States.

MUCH progress has been made of late years in the study of fruit growing, especially with reference to orchard heating and the development of more accurate methods of predicting low temperatures and counteracting their damaging effects. Special information has been given in the U.S. *Monthly Weather Review* for different districts, notably for North Carolina, in Supplement No. 19, published last year; and the *Monthly Weather Review* for December last has an article on "Damaging Temperatures and Orchard Heating in the Rogue River Valley, Oregon," by Mr. F. D. Young, Meteorologist, and Mr. C. C. Cate, Plant Pathologist. Observations made in the past with regard to temperature are utilised by the authors.

The pear is the principal fruit crop of the valley, but so far less has been done in determining the damage by cold to this crop than to peaches, apples, and apricots. A large part of the article deals with the actual comparisons of the pear crops harvested from adjoining protected and unprotected orchards during the seasons of 1921 and 1922, and partially with 1923. The cold due to radiation with a clear sky is the special lowering of temperature dealt with. The upper and less protected parts of the tree feel the effect of radiation more fully. Fruit blossoms were examined and the extent of damage noted for the different exposures under examination, and from 150 to 350 blossoms were cut open and examined in determining percentages of damage at each count. The protected orchard is equipped with a various number of oil-heaters, ranging from about 9 to 250 2-gallon lard-pails to the acre. Graphs are given showing the range of temperature at unheated check stations and at heated orchards, the heating, in examples shown, making a difference of 4° to 8° F. The great value is clearly the maintenance of night temperature above the damaging point, say above about 30° F.

Excellent photographs are given showing the development of pear blossoms and fruit at different dates of progress, and of fruit in which the seeds have been damaged or undamaged by frost. Photographs also show the crop, in number of pears at different heights on the tree; for example — ground to 6 ft., 6-10 ft., 10-14 ft., and above. Also the cropping in boxes from respective trees in protected and unprotected orchards—ranging from more than 20 boxes to a single box—is given.

In one of the largest pear and apple orchards in the Rogue River Valley, orchard heaters have been used during the past thirteen years, and during that time the fruit crop has never been materially reduced through frost-damage. A rougher method of orchard heating was previously adopted, but it was far less efficacious.

Although the discussion under review deals only with the Rogue River Valley, it is stated that the effectiveness of orchard heating, where properly handled, applies with equal force in preventing damage by frost in Western Oregon and in the entire States of California and Washington. Detailed studies in southern California show that orange groves can be protected against outside temperatures of 18° F., and the protective value of heating is generally accepted by citrus growers throughout the State.

The economic phase of orchard heating has been intentionally ignored, although the authors give a few convincing facts in support of the cost incurred, and they note that, in the Pacific Coast States, orchard heating is generally practised only in the colder portions of each district.

University and Educational Intelligence.

LONDON.—Applications are invited for the William Julius Mickle fellowship of the value of at least 200*l.*, to be awarded to the man or woman who, being resident in London, and a graduate of the University, has in the opinion of the Senate done most to advance medical art or science during the preceding five years. Applications must be received before October 1 next. Particulars may be obtained on application to the Academic Registrar, University of London, South Kensington, S.W.7.

THE University of the Witwatersrand, Johannesburg, gives in its Calendar for 1924 an interesting sketch of its origin and development. From 1916, when the Witwatersrand University Committee was formed for the purpose of developing the South African School of Mines and Technology, first into a full University College and ultimately into a University, progress has been very rapid, the number of students in each of the years 1916 to 1923 having been: 77, 173, 191, 301, 635, 812, 983, 1106. The University, formally opened in October 1922, has now fully organised Faculties of Arts, Science, Medicine, Commerce, Engineering, and Law, and a teaching staff of a hundred professors and lecturers.

THE United States National Research Council has published in Bulletin No. 38, particulars of more than 400 foundations of fellowships and scholarships for advanced work in science and technology. The compilation is provided with a subject index which shows that about 170 foundations are for research in pure science, 140 for research in technology, and 65 for medical research. A comparison with Appendix xxiv. of the British Empire Universities Yearbook seems to show that it is a much commoner practice among American than among British universities to admit to candidature graduates of institutions other than those in which the fellowships, etc., are tenable. The practice has obvious advantages, especially in the case of a university which has achieved pre-eminence in the advanced teaching, or facilities for the advanced study of, one or more branches of knowledge. From one point of view it is complementary to the practice of giving travelling fellowships.

AN Education Week is being organised for November 17-23 by the United States Bureau of Education in co-operation with the National Education Association (representing the school teachers of the United States) and the American Legion. The celebrations are to be distributed over the week thus: Monday, Constitution Day—"The Constitution: the bulwark of democracy and happiness"; Tuesday, Patriotism Day—"The United States flag is the living symbol of the ideals and institutions of our republic"; Wednesday, School and Teacher Day—"The teacher: the guiding influence of future America"; Thursday, Illiteracy Day—"Informed intelligence is the foundation of representative government"; Friday, Physical Education Day—"Playgrounds and athletic fields mean a strong healthy nation"; Saturday, Community Day—"Service to Community, State, and Nation is the duty of every citizen"; Sunday, For God and Country Day—"Religion, Morality, and Education are necessary for good government." For each day, appropriate topics and slogans are suggested. Conspicuous among those for the first two days are the following: Revolutionists, communists, and extreme pacifists are a menace to our constitution's guarantees of life, liberty, justice, security, and opportunity; the red flag means death, destruction, poverty, starvation, disease, anarchy, and dictatorship; stamp out revolutionary radicalism.

Early Science at the Royal Society.

eptember 6, 1664. Sir Robert Moray produced a ter of Mons. Huygens, dated at the Hague, mention- g an instrument devised by him for measuring the locity of descending bodies; as also, a new observa- n concerning Saturn, made the last spring at Rome, Campani, viz., that the circle of Saturn had covered part of its sphere above, and had been covered ereby below, even with a little shadow upon the cle below, and upon the sphere above: which servation Mons. Huygens looked upon as confirm- g his system, which himself had made.

1666. Sir Theodore de Vaux presented a paper of lumineure which was recommended to Mr. Evelyn peruse. This gave occasion to mention that Mr. ovey had intimated, that, upon the society's desire, r. Peter Lely, Mr. Cooper, and Mr. Streeter would erhaps not be unwilling to communicate to them e several curiosities and varieties of painting. Thereupon it was ordered, that Mr. Povey, Mr. velyn [and others] should be desired to meet and nsider together what particulars were fit to inquire to, and thereupon to discourse with the said masters.

September 7, 1663. Dr. Wilkins put the company mind to improve their former consideration of aking an history of the weather, in order to build ereupon an art of prognosticating the changes ereof: And he suggested, that it might be re- mmended to some of the members of the society, to ake constant observations, at least of the most nsiderable changes of weather: in order to which, Mr. Hooke was desired to engage therein, which he id; and Dr. Wilkins undertook to recommend the ame to Dr. Power. It was also thought proper that Dr. Wren should be written to, to send to the society scheme of his weather-engine, formerly proposed, in rder to see whether it needed any addition or not. ir Kenelme Digby related, that Dr. Dee by a diligent bservation of the weather for seven years together, cquired such a prognosticating skill of weather, that e was, on that account, accounted a witch.—Mons. Huygens presented a paper from his father Mons. Zuylichem containing a description of a new kind of candlestick, by means of which, the candle upon it gives more light than two torches together, consumes ess wax, frees from the inconvenience of smoking in the narrowest room, and needs no snuffers. The paper was ordered to be translated from the French.

September 10, 1662. It was ordered, that at the next meeting experiments should be made with wires of several kinds of the same size, viz., silver, copper, iron, etc., to see what weight would break them; Mr. Croune being appointed curator of this experiment.—Dr. Wren was reminded of prosecuting Mr. Rooke's observations concerning the motions of the satellites of Jupiter.—A proposition was offered by Sir Robert Moray about the planting of timber in England, and the preserving of what was then growing.

September 11, 1661. Two committees were appointed to propound experiments, one consisting of Dr. Goddard, Dr. Wilkins [and others] for the city of London; and the other consisting of the lord Viscount Brouncker, Sir Robert Moray, Sir Paul Neile [and others] for Westminster.

September 12, 1679. There was a discourse about ways of vision, from the assertion of Mr. Hooke, that a man used to see things always inverted would in time judge, that he saw them as they are. Sir John Hoskyns remarked, that looking at the sun or stars through a small hole made in paper caused them to appear less than to the naked eye. Dr. Croune gave the reason of the sun's appearing bigger near the horizon from the dilating of the pupil.

Societies and Academies.

PARIS.

Academy of Sciences, August 4.—M. Guillaume Bigourdan in the chair.—A. **Lacroix**: A new type of meteoric iron found in the desert of Adrar, Mauritania.—F. E. **Fournier**: An unpublished safety manœuvre for preventing collisions between steamships during fog.—A. **Haller** and R. **Cornubert**: Study of two symmetrical and unsymmetrical dimethylpentanones. Symmetrical dimethylcyclopentanone condenses with benzaldehyde in the presence of hydrochloric acid, giving a compound $C_{21}H_{22}O_2$: the unsymmetrical dimethylcyclopentane behaves differently, giving a true benzylidene compound.—Gabriel **Bertrand** and Hirosi **Nakamura**: A new case of physiological mutation in mice.—P. **Sergesco**: Some inequalities of Landau and Lindelof concerning monogene functions.—J. **Cabannes** and A. **Lepape**: The diffusion of light by krypton and xenon. The polarisation of the light diffused transversely by a pure inert gas is not total.—J. **Guinchant**: Rôle of the atmosphere in the propagation of Hertzian waves. Effects analogous with mirage in the case of light waves can be produced with Hertzian waves. The state of the lower atmosphere may be an essential factor in the propagation of radio-telegraphic waves. The changes in intensity and of direction of the waves, the differences in receiving during day or night, and influence of the seasons may be readily explained by normal meteorological variations.—André **Job** and René **Reich**: The catalytic activation of ethylene by organo-metallic nickel. A solution of phenylmagnesium bromide, to which a little anhydrous nickel chloride has been added, rapidly absorbs large volumes of ethylene. Subsequent addition of water gives ethane, ethylbenzene, styrolene and diphenyl, but no benzene.—H. **Gault** and Mlle. M. **Urban**: The soluble cellulose esters of the higher unsaturated fatty acids.—Max. and Michel **Polonovski**: The nitroso and benzoyl derivatives of eserine.—Ch. **Maurain** and L. **Eblé**: A photographic recording seismograph with three components.—MM. **Rothé**, **Lacoste**, **Bois**, Mlle. **Dammann** and Mme. **Hée**: Study of the propagation of the La Courtine explosions.—E. F. **Terroine**, Mlle. S. **Trautmann** and R. **Bonnet**: The energy yield at the expense of the carbohydrates in the growth of the higher plants.—L. **Emberger**: Cytological observations on the bulb of *Lilium candidum*.—M. **Couvreux**: New observations on the photomotor reflex.—P. **Vlès**, P. **Reiss** and E. **Vellinger**: Potentiometric measurements of the P_H of the substance of the eggs of the sea-urchin. For the crude egg substance, the P_H appears to be between 5 and 5·5 before loss of carbon dioxide; it rises to about 6·2 when this gas has been eliminated.—Ch. **Dhéré**, A. **Schneider** and Th. **Van der Bom**: The photographic determination of the fluorescent spectra of hæmatoporphyrine in various solvents.—J. **Régnier**: The variation of the anæsthetic power of cocaine hydrochloride as a function of the proportion of hydrogen ions. The rapidity of anæsthesia is much more rapid for alkaline than for acid solutions. With high P_H, anæsthesia is complete in two minutes.

August 11.—M. Guillaume in the chair.—A. **Lacroix**: The meteoric irons of Senegal and the Sahara.—A. A. **Guntz**: The energy set free in phosphorescence.

CALCUTTA.

Asiatic Society of Bengal, August 6.—Satya Churn **Law**: *Parus major cinereus* breeding in the 24 Perghanas. Two instances of the breeding of this

bird in the suburbs of Calcutta in the district of 24 Perghanas are recorded. Hitherto there was nothing on record about its nidification in this district.—Satya Churn **Law**: Kālidāsa and the migration of birds. Migration may not have been understood by Kālidāsa, but the phenomenon itself did not escape him. Scattered about in his works are passages which unmistakably refer to this peculiar feature of bird-life, and there are many expressions relating to birds which can be explained only with reference to the migratory phase of their life.—Bisvesvar **Bhattacharyya**: The age of the Padmā. Literary and historical argument in support of the thesis that the Padmā or lower course of the Ganges grew to its present size not during the 16th century A.D., as commonly held, but perhaps during the 14th, or even 13th, century.—Bimala Charan **Law**: The Aśmakas or Assakas in ancient India. A discussion regarding the name and origin of the Assaka tribe and a brief account of its traditional history as may be gleaned from Brahmanical and Buddhist literature.—J. H. **Hutton**: Some carved stones in the Dayang Valley. Descriptive of a little-known group of carved menhirs at Kasomari-pathar near Jamugiri, hitherto only known from a brief description by Bloch in 1905. A connexion may exist between the stones and surviving ceremonies of the Naga tribes.—A. **Grignard**: Our Romanised Hindustani-English dictionaries: their partial inefficiency and its remedies.—Lily **Strickland-Anderson**: Some notes on the customs of the Khasi people of Assam.

Official Publications Received.

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 2, No. 2: Mälarens Isförhållanden vintrarna 1917/18–1921/22. Av J. V. Eriksson. Pp. 20+4 plates. 3 kr. Band 2, No. 3: Nederbördskartor över Sverige. Av Axel Wallén. Pp. 8+3 plates. 2 kr. (Stockholm.)

Abisko Naturvetenskapliga Station. Observations météorologiques à Abisko en 1922. Faites et rédigées par Bror Hedemo. Pp. iv+66. (Stockholm.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 4, 1922. 3: Vattenstånden vid Rikets kuster. Pp. 25+5 plates. 4 kr. Årsbok, 5, 1923. 2: Nederbörden i Sverige. Pp. 172+1 plate. 5 kr. (Stockholm.)

U.S. Department of Agriculture: Weather Bureau. Cloud Forms, according to the International System of Classification. Pp. 22. (Washington: Government Printing Office.)

Twickenham Public Library. Thirtieth Report, 1923–24. Pp. 12. (Twickenham, Middlesex.)

Technical College, Bradford. Prospectus of Part Time Courses. Prospectus, Session 1924–25. Pp. 192+26 plates. (Bradford.)

Northampton Polytechnic Institute, St. John Street, London, E.C. Announcements, Educational and Social, for the Session 1924–1925. Pp. 240+4 plates. (London.)

London County Council. Lectures and Classes for Teachers: Handbook for the Session 1924–25. Pp. 74. (London: County Hall, S.E.1.)

Agricultural Experiment Station of the Rhode Island State College. Bulletin 197: The Examination of Eggs from Infected and Immunized Hens, with Germicidal Tests on Albumen and Blood Serum. By Henry G. May. Pp. 47. (Kingston, R.I.)

The Cordwainers Technical College, Eagle Court, St. John's Lane, E.C.1. Prospectus of Classes in Boot and Shoe Manufacture and Making, Leather Goods Manufacture and Leatherware Art Work, Day and Evening Classes, Session 1924–5. Pp. 43. (London.)

Southern Rhodesia Geological Survey. Short Report No. 16: Interim Report on the Geology of the Country South of Umsweswe, Hartley District. By A. M. Macgregor. Pp. 18. (Salisbury, Southern Rhodesia.)

The Animal Products Research Foundation of the University of Adelaide. Third Annual Report, 1923. Pp. 4+21+3+9+12. (Adelaide.)

Queensland. Department of Mines: Queensland Geological Survey. Publication No. 273: Mesozoic Insects of Queensland. By Dr. R. J. Tillyard and B. Dunstan. Part 2. By R. J. Tillyard. Pp. 175-506+19 plates. (Brisbane: A. J. Cumming.)

The British Dyestuffs Industry 1856–1924. A Booklet issued by the British Dyestuffs Corporation, Ltd., on the occasion of the British Empire Exhibition, 1924. (Manchester: 70 Spring Gardens.)

British Empire Exhibition, Wembley. The Imperial Institute Exhibit in the Pavilion of His Majesty's Government. Pp. 30. (London: Imperial Institute.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 490: Spectra and Critical Potentials of Fifth Group Elements. By Arthur E. Ruark, F. L. Mohler, Paul D. Foote, and R. L. Chenault. Pp. 463-486. (Washington: Government Printing Office.) 10 cents.

United States Department of Agriculture. Department Bulletin No. 1218: Horse-Flies; Biologies and Relation to Western Agriculture. By J. L. Webb and R. W. Wells. Pp. 36+4 plates. (Washington: Government Printing Office.) 10 cents.

Board of Education. Report for the Year 1923 on the Science Mus... Pp. 20. (London: H.M. Stationery Office.) 9d. net.

Experimental Researches and Reports published by the Departm... Glass Technology, The University, Sheffield. Vol. 6, 1923. Pp. ... (Sheffield.)

Contributions from the Princeton University Observatory. N... Photometric Researches. The Eclipsing Variables Y Camelopar... S Z Herculis, R S Vulpeculæ, R Canis majoris, R Y Aquarii. ... Raymond Smith Dugan. Pp. 66. (Princeton, N.J.)

Smithsonian Institution: United States National Museum. Bul... 99: East African Mammals in the United States National Museum. ... N. Hollister. Part 3: Primates, Artiodactyla, Perissodactyla, Pr... cidea, and Hyracoidea. Pp. viii+164+57 plates. 40 cents. Bul... 104: The Foraminifera of the Atlantic Ocean. Part 5: Chilostome... and Globigerinidæ. By Joseph Augustine Cushman. Pp. v+55+8 pl... 15 cents. (Washington: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, ... No. 2: Industrial Schools for Delinquents, 1921–22. Prepared by ... Division of Statistics of the Bureau of Education under the Superv... of Frank M. Phillips. Pp. 22. (Washington: Government Prin... Office.) 5 cents.

Smithsonian Institution: United States National Museum. Conti... tions from the United States National Herbarium. Vol. 22, Part 7: ... North American Species of Aristida. By A. S. Hitchcock. Pp. viii+... 586. (Washington: Government Printing Office.) 10 cents.

Department of the Interior: United States Geological Survey. W... Supply Paper 520-B: Additional Ground-Water Supplies for the Ci... Enid, Oklahoma. By B. Coleman Renick. Pp. ii+15-26. Bulletin ... Geologic Literature on North America. By John M. Nickles. Par... Index. Pp. 658. 65 cents. Mineral Resources of the United St... 1921. Part 1: Metals. Pp. iv+130A+599-617. (Washington: Gov... ment Printing Office.)

Annual Reports of the Academy of Natural Sciences of Philadelphi... the Year ending November 30, 1922. Pp. 98+8 plates. (Philadelphia, ...

Year Book of the Academy of Natural Sciences of Philadelphia, 1... Pp. 96+9 plates. (Philadelphia, Pa.)

Museums of the Brooklyn Institute of Arts and Sciences. Report u... the Condition and Progress of the Museums for the Year ending Decen... 31, 1923. By William Henry Fox. Pp. 60+3 plates. (Brooklyn, N.Y.)

The Journal of the Royal Horticultural Society. Edited by F... Chittenden. Vol. 49, Part 2, July. Pp. 139-304+lxxi-cxxvii. (Lond... Vincent Square, S.W.1.) 7s. 6d.

Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C. Sylla... of Classes, Session 1924–1925. Pp. 107. (London.)

Smithsonian Miscellaneous Collections. Vol. 67, No. 9: Camb... Geology and Paleontology, IV. No. 9: Cambrian and Ozarkian Brac... poda, Ozarkian Cephalopoda and Notostraca. By Charles D. Walc... (Publication 2753.) Pp. 477-554+plates 106-126. Vol. 75, No. ... Cambrian Geology and Paleontology, V. No. 1: Geological Formati... of Beaverfoot-Brisco-Stanford Range, British Columbia, Canada. ... Charles D. Walcott. (Publication 2756.) Pp. 51+8 plates. (Washingt... Smithsonian Institution.)

Report for 1923 on the Lancashire Sea-Fisheries Laboratory at ... University of Liverpool and the Sea-Fish Hatchery at Piel. Edited ... Prof. James Johnstone. Pp. 129. (Liverpool.)

Diary of Societies.

MONDAY, SEPTEMBER 8.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8 P.M. ... W. M. Corse: Recent Developments in Non-Ferrous Metallurgy in ... United States, with Special Reference to Nickel and Aluminium-Bron... (Third Annual Autumn Lecture.)

TUESDAY, SEPTEMBER 9.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 10 A.... —R. J. Anderson and E. G. Fahlman: A Method for measuri... Internal Stress in Brass Tubes.—D. H. Andrews and Prof. J. Johnsto... The Application of the Ideal Solubility Curve to the Interpretation ... Equilibrium Diagrams in Metal Systems.—Dr. G. D. Bengough and ... May: Seventh Report to the Corrosion Research Committee of t... Institute of Metals.—E. H. Dix, Jr., and Lieut. A. J. Lyon: Co... parative Results on Copper-Silicon-Aluminium and other Aluminiu... Alloys as obtained on Separately Cast Specimens and Specimens c... from a Crankcase Casting.—D. M. Fairlie and G. B. Brook: T... Determination of Sodium in Aluminium.—R. Genders: The Extrusi... of Brass Rod by the Inverted Process.—Dr. D. Hanson and Grace ... Ford: Investigation of the Effects of Impurities on Copper. Part ... The Effect of Iron on Copper.—D. H. Ingall: The Relationsh... between Tensile Strength, Temperature, and Cold-Work in some Pu... Metals and Single Solid Solutions.—Dr. H. Moore: The Effect ... Progressive Cold-Rolling on the Brinell Hardness of Copper.—... Thomas K. Rose and J. H. Watson: Experiments on the Working ... Nickel for Coinage.—F. W. Rowe: (*a*) Some Experiments on the Effe... of Casting Temperature and Heat-Treatment on the Physical Propert... of a High-Tin Bronze; (*b*) Some Experiments on the Influence ... Casting Temperature and Mass on the Physical Properties of Admiral... Gun-Metal.—Tomojiro Tanabe: Studies in the Aluminium-Zinc Syste... —T. H. Turner and W. E. Ballard: Metal Spraying and Spray... Metal. (A selection of above Papers will be presented in abstract a... discussed.)

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. L. Hodgson: T... Measurement of Pressure.

WEDNESDAY, SEPTEMBER 10.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 10 A.... —(A selection of the Papers given above will be presented in abstra... and discussed.)

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Editorial and Publishing Offices :

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2863, VOL. 114]

Science and Religion.

THE assembly of the Conference of Modern Churchmen at Oxford at the end of last month, and the adoption of the subject "The Scientific Approach to Religion" as the theme of the discussions, seem to suggest the present as an opportune moment for reconsidering the old question of the relation between scientific and religious doctrine. The atmosphere of this clerical conference was totally different from that of other ecclesiastical congresses where scientific questions have been under discussion. There was an almost complete absence of traditional presuppositions —in fact, there seemed to reign a determination to get back to first principles, and build upon the same foundation as that on which scientific teaching is based, namely, the ultimate nature of things—in a word, the structure and meaning of the universe.

The functions of religion and science are different both theoretically and practically, but it seems to us that both are equally necessary for the welfare of the human race. Religion differs in its theoretical aims from science, because the aim of science is the constant pressing forward to the discovery of new truth, whilst that of religion is the holding fast and transmitting to posterity of truth that has already been ascertained. On the practical side, the object of science is to adapt man ever more closely to his environment, and, so far as he can master it, to adapt the environment to him, whilst that of religion is to furnish the sanctions for the laws which hold society together. It may perhaps be objected that the delights of scientific investigations are able to support the man who pursues them in all the troubles of life without any assistance from religion whatever. This is undoubtedly true, but it does not carry us very far. For scientific work is impossible except in the environment of a civilised society, and the carrying on of such a society implies the performance of a great deal of monotonous and uninteresting work. The attempt to crush religious belief, and thus to persuade those who perform this work to persevere in the absence of the comfort and hope supplied by the Church, has proved a disastrous failure every time that it has been attempted. We have just witnessed the last of these attempts, that of the Bolshevists in Russia, which has resulted in consequences patent to all the world.

The conference was opened by an address by the president, the Very Rev. W. Inge, Dean of St. Paul's, who is distinguished above most other Churchmen by his knowledge of and sympathy with science, and it was closed by a sermon delivered by Canon Barnes, Bishop-designate of Birmingham, who was an eminent

scientific man and a fellow of the Royal Society before he entered the service of the Church.

If religious beliefs are founded on an ineradicable element in human nature, then nothing can be more disastrous than an irreconcilable cleavage between these beliefs and the teachings of science. It is, as Dean Inge said, an "open sore," and he added that to contribute in some measure to the healing of the sore was the main object of the conference. But religious truth is necessarily expressed in terms of the "Weltanschauung" of the period at which it was first promulgated. This "Weltanschauung" is just the science of the time, and as it becomes changed the religious truth is left embedded in a setting of outworn ideas. The aim, therefore, of the reconciler must be to extract the "timeless element" in religion from this setting and express it, so far as possible, in a pure and unadulterated form. This element Dean Inge finds in the "values"—goodness, truth, and beauty. These he declares to be the most real things in the universe: from their permanence he deduces not only the existence of God in whom they are completely realised, but also the permanence of those elements in us which respond to these values and seek for their complete expression.

Profs. Haldane and MacBride were invited to the conference as respectful and sympathetic outsiders, in order to state as clearly as possible the modern positions on vitalism and evolution. Prof. Haldane emphatically asserted that the action of living beings cannot be explained upon mechanical principles—it is theoretically possible to construct a series of imaginary machines the working of which will simulate more or less closely the actions of living beings; but as our knowledge of the details of these actions grows, so the machines become more and more complicated—and the futility of the whole procedure is shown by the fact that no account whatever can be given of the "mechanism" by which these machines come into being or how these supposed intricate structures emerge from the egg. Prof. MacBride pointed out that the acceptance of evolution necessitated the entire recasting of the Mosaic cosmogony and of the doctrines of sin and the fall set forth by St. Paul, and he also directed attention to the great outstanding difficulty in the way of any theory of a beneficent Author of the universe, namely, the cruelty and carnage involved in the elimination of the unfit. On the other hand, whilst giving a résumé of the well-known evidence for animal evolution, Prof. MacBride pointed out that "natural selection" gives no explanation of the process any more than the pruning-knife can account for the forces of growth in the plant; that the driving force of evolution is the power of the living being to rise up to meet adverse circumstances and, adapting itself to them, to overcome them; and th the powers acquired by the parents are transmit to the children. Evolution, therefore, in the pro sense, is a vital phenomenon which can be exhibi only by living beings, and to use it to include t physical and chemical processes involved in the cooli of a heated globe, for example, as did Herbert Spenc is to empty it of its essential meaning. In princip therefore, Prof. MacBride and Prof. Haldane agreed

The president in his opening address had touch on the limitations of scientific explanations. Scien knows nothing of origins or ends but only of process In a rigidly defined mechanical system, change a adaptation are impossible; moreover, if the cosm as a whole is regarded as a mechanical system, th it is not self-explanatory, for it is not a static syst but is "running down." No reason can be assign why it should not have already reached equilibrium we postulate an indefinite period of past time. The must be something permanent behind it—and th something which the religious soul quests for, a to which it believes itself to be akin, is God. Pr De Burgh's paper connects at this point with I Inge's address; for he dealt with the stupendo subjects of God, time, and eternity. In a most brillia essay he pointed out that the idea of time as a me flux of vanishing "nows" is inconceivable and se contradictory—that there must be a permanent ba underlying it, and this permanent basis he identifi with eternity. He thought that whilst an "Absolute of some kind was a necessary postulate of reason, required the religious experience to convince us the existence of God. This we think rather dangero reasoning. The word "God" is just the name giv by the plain man to the reality behind the compl of circumstances surrounding him, by which he limited and controlled. He is conscious of stron desires, and conceives purposes in the execution which he is frequently frustrated; therefore in th world around him there is an "other" to which h is frequently opposed. On any theory of evolutio his own nature and personality have somehow bee evolved out of this "other." Can the stream ri higher than its fountain? "He that planted the ea shall He not hear?"

Of course, it may be objected that these searche for the ultimate, these aspirations after union wit the divine, can never give us anything but pleasan dreams, whereas science supplies us with solid fact on which we can depend. This contrast between th certainty of science and the vagueness and uncertaint of religion sounds obvious, but we are not at all sur that it will stand critical examination. After al

hat are "facts"? "The ordinary man," said that ute philosopher McTaggart, "thinks that he knows cts; but when we analyse these 'facts' they turn it to be a compound of sensations and thoughts." is vain for the physiologist to point out that con- iousness appears in Nature as a mere epiphenomenon ssociated with the chemical changes in certain organic mpounds. When he uses reasoning like this, he nplicitly separates his own reason and perception om the rest of the world, and views the workings f other conscious beings from the outside. "I can- ot conceive of matter," said the candid Huxley, apart from mind to picture it in." To quote another ambridge philosopher: "From one point of view onsciousness appears a temporary phenomenon associ- ted with certain forms of matter, but when we look t it from another point of view it swallows every- hing else. Both views are true, and we do not ealise what a wonderful universe we dwell in till we ave grasped this fact."

Religion is sometimes regarded from the evolutionary oint of view as a defence mechanism which has been rought into being to support and encourage the ommunal life of the tribe, but reason and its product cientific knowledge may, with equal justice, be regarded as a food-getting mechanism evolved to enable us to feed ourselves, and in no way to be considered as capable of giving us accurate information about the universe. Indeed, if we for a moment assume the validity of our own sensations and view our fellow-man from without, what ground have we for supposing that his sensations will give him any accurate picture of the world around him? How can a vibration in the ether impinging on a retinal cell and setting up therein chemical changes which result in the "stimulation" of a nerve cell, and the transference of this "stimulation" to the brain, give any information as to the nature of the body from which the vibration proceeded? Yet, if we do not make this assumption, there is an end to science. If we, therefore, following our natural instincts, trust our senses to tell us what the universe is like, why should we not trust our religious instinct as to the kinship between our own spirits and the Ultimate Reality? The question, therefore, of the "validity" of our knowledge must be separated from all speculations as to its evolutionary origin.

The fundamental difficulty of the whole situation is that the man of science and the philosopher alike strives each to construct a complete system to include the whole universe. The humbler and more correct attitude is that of Huxleyan agnosticism, which, as Prof. MacBride pointed out at the conference, is entirely compatible with the Christian faith; for this faith is a determination to stake everything on the hope that the "values" will turn out to be real and eternal. In the obituary notice of Huxley published in NATURE and written by his pupil, Sir Michael Foster, there appears the sentence, relating to the problem of the survival of the soul, "Huxley was convinced that science could never with all its endeavours avail to raise one corner of the veil concealing that dream by which our life is rounded."

Perhaps we may best sum up the whole matter in the words of that scientific theologian, Harnack:

"In spite of intense effort our modern thinkers have not succeeded in developing a satisfactory system of ethics and one corresponding to our deepest needs on the basis of monism. They will never succeed in doing so. If this be admitted it is in the last resort a matter of indifference with what names we designate the two sides of the dualism which, as moral and thinking men, we encounter—for instance God and the World, Here and Hereafter, Visible and Invisible, Matter and Spirit, Necessity and Freedom. Unity can be *experienced* and one side can be subordinated to the other, but this unity is always reached by a struggle in the form of an endless problem which can only be approximately solved, and never by the refinement of a mechanical process. We are not able to bring our knowledge of time and space into the unity of a consistent Weltanschauung with our inner life. Only in the peace of God which is higher than all reason can we catch a glimpse of their ultimate unity."

The Rarer Elements.

Chemistry of the Rarer Elements. By Prof. B. Smith Hopkins. Pp. vii + 376. (Boston, New York, Chicago, and London: D. C. Heath and Co., 1924.) 15*s.* net.

THE reader's interest will be aroused even before he has opened this volume; for he will doubtless be curious to learn which members of the elemental series the author has decided to group together under the rubric of "rarer elements." The preface furnishes a satisfactory definition. Prof. Hopkins has taken as his province "those elements which are little known either because of scarcity, neglect, or ignorance." His object has been "to call attention both to the advances which have recently been made in our knowledge and also to the need of further research in the development of many of the less familiar elements."

It must be confessed that, to the non-specialist, many of the books hitherto written about the rarer elements are more than a little dry. Before opening them, the would-be reader has a foreboding—often justified in the event—that he will find within the covers simply the usual accumulation of facts carefully grouped under certain set headings: facts, individually

important, which seem to resist any attempt to force them into any far-reaching and logical scheme. This apparent incoherence of the data attains its culmination in the case of the rare earth group, where, although the proper elemental sequence is indisputable, no generally accepted system has yet been evolved which will bring the elements into line with each other or with the remaining forms of matter which we know.

There is another pitfall in the path of a writer upon the rarer elements. Owing to the fact that he is making an arbitrary selection from the material, he runs a grave risk of isolating the elements with which he deals from their commoner brethren; and in this way he tends to produce the impression that these rarer elements stand in a class by themselves, that gallium, for example, is in some mysterious way to be mentally segregated from the remainder of its group.

Prof. Hopkins's book avoids both of these difficulties. He gives the reader a general description of the salts of each of the elements with which he deals; but he has resisted the temptation to insert data simply because they are known. The result is that his book holds the reader's interest without difficulty, even in those places where dulness might be expected to supervene.

Even more praiseworthy is the fact that he never allows the student to forget the relations existing between the elements as a whole and the particular one which is under discussion. The book opens with a chapter on the Periodic System, in which some of the recently suggested forms of the Periodic Table are described and the possibility of further discoveries of new elements is examined. This forms the frame into which the rarer elements are fitted one by one. But, in addition to this, each section of the book is headed by an excursus in which a general survey is made of the group containing the special rare elements under discussion in that section. Thus the peculiar mental partition between the "rarer" elements and the "commoner" elements is never allowed to grow up in the mind of the student.

Another feature which makes the book specially valuable to the student is the way in which the practical importance of the rarer elements is emphasised in detail; for in some books the impression is left that these substances are mainly of academic interest. Prof. Hopkins, without overloading his pages, has succeeded in tracing the ramification of these rarer elements into commercial practice; and his chapters cannot fail to suggest that we are as yet only on the frontier of a great development. As a rule, the author deals in turn with the history of the element, its occurrence in Nature, its extraction and metallurgy, its properties, its uses, and he terminates his sections with brief descriptions of the more important compounds and the methods whereby they may be identified.

The publication of books of this type seems to be one of the hopeful features of modern chemical literature. In the past there was an appreciable gap between the college text-book on one hand and, on the other, the German compendium in six or more volumes which generally, with quite unconscious humour, was entitled a "Hand-book"; and the student who had just mastered the elements was apt to be intimidated when faced with his next step in the literature of his subject. Nowadays, with excellent series of monographs from British and American publishers, the student is much better off. He can get his information on certain subjects without having to wade laboriously through huge systematic "text-books". Thus he is able to attain a reasonable standard of knowledge without being discouraged by the force of realisation of how much he does *not* know; while at the same time his interest is sharpened and he is encouraged to go forward in the pursuit of a more complete knowledge. Chemistry, with all its modern ramifications, has long passed the stage when any one except the mere book-worm can pretend to "know" the whole of it in detail; and the recent trend in chemical literature away from the cast-iron systematic text-book has been all in the interest of the student who has just completed his course and is looking forward to extending his knowledge. Books like that of Prof. Hopkins are to be welcomed. A. W. S.

Geology of the United States.

A Text-Book of Geology: for Use in Universities, Colleges, Schools of Science, etc., and for the General Reader. By Prof. Louis V. Pirsson and Prof. Charles Schuchert. Part 2: *Historical Geology.* By Prof. Charles Schuchert. Second, revised edition. Pp. ix+724. (New York: J. Wiley and Sons, Inc. London: Chapman and Hall, Ltd., 1924.) 22*s.* 6*d.* net.

ORIGINALLY published nine years ago, Pirsson and Schuchert's Text-book has become the most popular introduction to geology among American students, and its well-merited supremacy is now likely to be still more firmly established by the issue of a second edition in which it has been thoroughly revised and brought up-to-date. The first volume, by the late Prof. Pirsson, deals with physical geology and is naturally of wider interest than the second part—now under review—in which Prof. Schuchert lucidly sets forth the principles of stratigraphy and palæontology and the broader features of the geological history of

United States. Compared with its first edition, second volume is now increased by about eighty ges, a series of palæogeographical maps have been roduced, and the Ozarkian has disappeared as a stem, the formations known by that name being now garded as the closing epoch of the more familiar mbrian. Eozoon is still thought to represent the rliest known evidence of calcareous algæ. As in the st edition, there are no detailed references, but this fect is met by appending to each chapter a list of ggestions for further reading. It is worthy of notice at British work has not been neglected as it so often in American books. Moreover, the Period names e retained for the most part in their original forms, d such terms as "Permic" are happily given no pport.

The treatment of the work as a whole is very much oader than the title indicates, for interspersed with e stratigraphical chapters there are just as many aling with palæontology. These, with others of neral interest, on such topics as astronomy, biology, d evolution, make up a composite course of about rty-five lectures.

In teaching historical geology, it is logically but unrtunately necessary to plunge straight away into the tricate labyrinth of the Archæan; to start as closely possible to that vague "beginning" of which Hutton uld find no certain trace. The difficulty is one, owever, that can be fairly met and overcome. But und scientific method becomes impossible when the bject is made to begin with the origin of the earth d its "pre-geological" history. These are problems at belong more properly to geophysics, problems hich will be attacked with success only when the rth's age, its thermal history, the origin of the ntinents, and other fundamental questions have been lved with a greater degree of confidence than is yet ssible. It will nevertheless be refreshing to British aders to find that the influence of the planetesimal ypothesis and of its author's more personal opinions now apparently steadily waning. This is mainly the sult of criticisms by Daly and Barrell, the latter, efore his lamented death, having clearly influenced he teaching of the book. Although no mention is ade of the work of Harold Jeffreys (whose new book n geophysics leaves no excuse for that omission n future), the conclusion that the earth must have assed through a fluid state is accepted for other easons.

A very interesting chapter deals with the perennial uestion of the permanency of the continents, but the roblem of their origin is not solved by the speculations ffered. The difficulty is essentially to explain the teral differences of density between the lighter continental and the heavier oceanic segments of the earth's crust. It is suggested that heavy flows of widespread magma broke through the crust over wide areas and caused them to subside into ocean basins; but unless the magmas were very much more dense than we have any reason to suppose, the new surface would be no lower than the original one, and the vertical distribution of densities would be unstable in a way that should since have disclosed itself in the petrology of the oceanic igneous rocks. Pushing the light rocks down to great depths does not solve a problem, which is one of lateral, not vertical, differences.

Other general chapters deal with coal, petroleum, geological climates of the past, man's place in Nature, and the age of the earth. Joly's recent views based on pleochroic haloes are referred to but not accepted. Schuchert concludes that the hour-glass of denudation and sedimentation has not been read correctly by the majority of geologists in the past, and that the earth is at least 500 million years old.

Regarded as a college text-book, perhaps too much space is devoted to speculative matters and not enough to the economic resources of the systems or the igneous history of the continent, though these aspects of the subject are by no means wholly neglected. The stratigraphical chapters naturally take their main inspiration from the country of the author, and little attempt is made to correlate with Europe. The appeal of the book is therefore limited from the point of view of the British student, for whom, indeed, it is unsuitable as a text-book. It is, however, full of ideas for teachers of the subject; it may be confidently accepted as the most up-to-date and authoritative summary of the geology of the United States; and it is consequently worthy of a place in every reference library.

ARTHUR HOLMES.

Co-ordination of Numerical Data.

The Calculus of Observations: a Treatise on Numerical Mathematics. By Prof. E. T. Whittaker and G. Robinson. Pp. xvi+395. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1924.) 18*s*. net.

A SET of numerical data, whether obtained from theory or experiment, gives rise to mathematical problems of interest and importance. The consideration of these problems now forms an important branch of pure mathematics: apart from this, some knowledge of them is required by workers in many fields —astronomers, meteorologists, physicists, engineers, naval architects, actuaries, biometricians, and statisticians. Until recently the subject has received but little attention in the mathematical departments of

British universities. During the last ten years, however, interest in it has been thoroughly aroused, especially in the Universities of London and Edinburgh. To Prof. Karl Pearson, head of the Department of Applied Statistics at University College, London, is due the credit of organising a mathematical laboratory for dealing systematically with numerical problems. During the War, Prof. Pearson's laboratory was occupied with numerical work on ballistics: more lately it has produced a series of tracts on computation. In Edinburgh, Prof. E. T. Whittaker has also organised a mathematical laboratory, and the volume before us may be regarded as a manual of the methods that have been evolved there.

The first four chapters, on interpolation and difference formulæ, are also published as a separate tract under the title "A Short Course in Interpolation" (price 5*s*. net). To a mathematician this section is much more convincing than those accounts of the subject which aim primarily at the application of interpolation to engineering or actuarial work. In particular, the important chapter on divided differences has not, we think, appeared before in any English book. Some of the early worked examples involve fifteen-figure numbers, and seem unnecessarily heavy: all the principles at stake could be amply illustrated by numbers of seven or eight digits.

The long sixth chapter gives an account of many useful methods of obtaining the numerical solution of an algebraic or transcendental equation. In numerical work, Horner's process of successive approximation is often found to be less useful than the root-squaring method of Graeffe. Graeffe's method, unlike Horner's, is easily adaptable to the location of complex roots—a problem the importance of which has greatly increased of late through its occurrence in determining the stability of an aeroplane. When an algebraic equation has only one or two pairs of complex roots, Graeffe's method is sufficient to isolate them without difficulty. A recent modification of the method, due to Prof. Brodetsky and Mr. Smeal, enables any number of complex roots to be located: we hope that this discovery will be added to the next edition of the work under notice.

Only the first seven chapters will normally be read as part of a university undergraduate course. A separate volume containing this part of the work alone would appeal to a wide class of readers. The rest of the book, from Chapter viii. onwards, forms an introduction to the mathematical theory of statistics, which, normally, will be read only by graduates engaged on research. Compared with the first seven chapters, this part of the work is too heavy, and the introductory matter leading up to it is inadequate.

When the Edinburgh laboratory was founded in 1913, a trial was made, so far as possible. of ev method which had been proposed for the solution the problems under consideration, and many of th methods were graphical. During the ten years t have elapsed since then, the graphical methods h almost all been abandoned, as their inferiority become evident, and at present the work there almost entirely arithmetical. No previous book any language contains the matter collected here a ten years' experience of dealing with numerical da The authors are to be heartily congratulated successfully producing a book that gives the result so much pioneering work. W. E. H. B

Our Bookshelf.

Emergency Water Supplies for Military, Agricultu and Colonial Purposes: Based on Experience of Mediterranean Expeditionary Force Operations, w Special Reference to the use of Drive Tube Wells a Drilling. By A. Beeby Thompson. Pp. xii + 18 45 plates. (London: Crosby Lockwood and S 1924.) 21*s*. net.

Possibly no problem is of such vital importance the pioneer and settler as that of the location o suitable source of water supply for drinking and pota purposes; scarcely less inevitable is the problem connexion with military incursions into countries wh are destitute of uncontaminated surface supplies a ill-suited for overland transport. Therefore, to classes of adventurers and explorers, whether prospe ing, colonising, or expeditionary, Mr. Beeby Thompso book, with its valuable record of methods and c trivances used in connexion with the Mediterran Expeditionary Force operations, will come with w come interest, affording much practical precept a useful advice.

Upon diviners or dowsers, Mr. Thompson looks w sceptical eyes. He allows some to be honest, but frankly suspicious of them all and their metho Their inconsistencies, not less than their failures, fill h with distrust; yet he is not above letting them hav trial. "In the absence of any definite scientific reas for locating a well at a particular spot, the dow could be given his chance, and to the author's knc ledge the location of small supplies has resulted several occasions." Mr. Thompson is certainly fair.

The book proceeds, however, on a more scient basis than any which governs the dowser in his pr nostications. The origin of water is discussed, t incidence of rainfall, the amount of run-off, the le of water tables, sources of potable water, and the va of hygienic measures; and thereafter follows a ser of chapters on the driving of tube wells, drilling ope tions, pumping equipment and water analysis, w illustrations from actual experience in Bulgaria, Serl (why does the author write Servia ?), Macedonia, a elsewhere. Full of practical direction and experimen information, the book should be a valuable guide to

o seek water supplies in unexplored or undeveloped ions.

Mr. Thompson comments on a fact which he states racted notice and inquiry during the War, namely, he comparative permanence of springs high up on ountain ranges after long periods of drought when ose lower down commenced to fail," and he advances e reasons, separately or collectively, to account for e phenomenon. It would be interesting to know the tent to which this characteristic was observed and nether it was so general as to be really remarkable.

BRYSSON CUNNINGHAM.

he Plant Alkaloids. By Dr. T. A. Henry. Second edition. Pp. viii+456+8 plates. (London: J. and A. Churchill, 1924.) 28*s.* net.

WHEN Dr. Henry published the first edition of his Plant Alkaloids" ten years ago, general satisfaction as felt and expressed at the appearance in English a really comprehensive work on so important a ubject, and at the masterly way in which the author ad dealt with it. Since then, notwithstanding the eneral interruption of such work due to the War, any investigations have been made and many searches published on the isolation, constitution, nd properties of the alkaloids. One need only ention such examples as the investigation of the lkaloids of ergot, opium, areca nut, pomegranate ark, belladonna, cinchona, Calabar bean, ipecacuanha, ohimbe bark; of the oxidation products of brucine y Leuchs and his collaborators, of the constitution f chelerythrine by Karrer, of chelidonine by Gadamer, nd so on, to realise the immense amount of material nat Dr. Henry had to examine critically and sift in ne preparation of the second edition of his work. Ie has succeeded admirably. Researches published n the spring of this year have received attention, lthough it may not have been possible for him to eal with them so fully as he may have desired.

Notwithstanding the large amount of fresh material o be dealt with, the size of the volume has not been ncreased, as that which had been superseded has een omitted as unnecessary. Methods of determin- ng the percentages of alkaloids in drugs have received ather less attention than formerly, and rightly so; ndeed, it is rather to be doubted whether these could ot in the future be relegated entirely to the books hat make such assays the subject of special attention. On the other hand, rather more space has been devoted o the discussion of such information as is available n the relation of chemical constitution to pharmaco- ogical action, a subject of surpassing interest but ne in which it is not yet possible to draw general conclusions. The six pages given to the pharmacology of the tropane group is a good example of the clear nd concise manner in which the author deals with his difficult problem.

Dr. Henry is to be congratulated on the successful accomplishment of his task. All who are interested in plant chemistry in general, or in the plant alkaloids in particular, will be glad to have at their disposal a work of reference that is thoroughly up-to-date and as trustworthy in its information as it is possible for such a work to be.

Handbook of the British Flora: a Description of the Flowering Plants and Ferns Indigenous to, or Naturalised in, the British Isles; for the Use of Beginners and Amateurs. By George Bentham. Revised by Sir J. D. Hooker. Seventh edition, revised by Dr. A. B. Rendle. Pp. lxi+606. (London: L. Reeve and Co., Ltd., 1924.) 12*s.* net.

THE publication of a new edition of Bentham's "Handbook of the British Flora" is of considerable importance to students and teachers of botany in Great Britain. There is no published work which better serves as an introduction to the British flora than this, and, though it can be strongly urged that we now need a completely new "Handbook," approximately on the lines of Schinz and Keller's "Flora der Schweiz," it is a good thing that the republication of Bentham and Hooker's Handbook has not been undertaken without a revision.

Dr. Rendle has most decidedly improved the work, and in many respects has made it more in accordance with modern knowledge and usage. The nomenclature now approximates—after allowing for very considerable differences in species standards—closely to that of Babington's "Manual" (10th edition). The chapter in the introduction on vegetable anatomy and physiology has been omitted, the etymology of generic names and indications of pronunciation have been added, while certain improvements have been made in classification, particularly of the Cryptogams. Descriptions of the relatively few additions, since the last revision, of "Benthamian species" to the British flora are inserted, and bibliographical references are given to some of the more important recent researches on the critical genera. In spite of these improvements, it seems a pity that the very "large" species standard has been retained even for the use of "beginners and amateurs." Modern field-botany tends so much towards ecology, and systematists often feel that the determination of species by ecologists is none too critical, that the need of a handbook with complete keys and adapted for field-work, but based on a conception of smaller, and often more actual, species, is greater than ever.

La Photographie des couleurs. Par Prof. J. Thovert. (Encyclopédie scientifique: Bibliothèque de Photographie.) Pp. viii+300+4 planches. (Paris: Gaston Doin, 1924.) 17·60 frs.

THE photography of colour is a subject that has been gradually growing in importance and extent during the last few decades, so that the time has come when it may well be treated of in more detail than is possible in moderate-sized manuals of photography in general. This volume is therefore a welcome addition to photographic literature. The author deals first with light and colour, including the transmission, refraction, diffraction, interference, and absorption of light, the production of spectra and their uses, and wave motion. The reproduction of colour by interference, dispersion, and by three-colour and two-colour methods follows, with practical instructions and theoretical considerations. Processes that have only a classic or historic interest are treated of sufficiently, but the special adaptation of methods to photomechanical processes is not included. The book is well and usefully illustrated, and has four good plates in colour.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Assignment of Lines and Term Values in Beryllium II and Carbon IV.

We have already published briefly the methods by which we have recently been able to determine with certainty the degree of ionisation of the atoms giving rise to many of the lines of the spectra produced by our "hot sparks," and in the case of Boron III the method by which the "Term Values" have been worked out (Proc. Nat. Acad., May 15, 1924. See also forthcoming articles in *Physical Review* and *Phil. Mag.*).

The object of the present note is to make a preliminary report upon the application of the same methods to the determination of the chief characteristics of the spectra of the "stripped atoms" of beryllium and carbon (Be_{II} and C_{IV}).

TABLE 1.

BERYLLIUM II.

Int.	λ I.Å. Vac.	ν Vac.		Term Values.
1	1512·31	66124·0	$(2p_2-3d)$	$4f$ − 27438·5±3
2	1512·45	66117·9	$(2p_1-3d)$	$3d$ − 48826·1±3
1	1776·27	56297·7	$(2p-3s)$	$2p_1$ −114943·7±3
1	4675·6	21387·6	$(3d-4f)$	$2p_2$ −114950·3±3
?	3132·086	31927·60	$(2s-2p_2)$	$2s$ −146877·9±3
?	3131·438	31934·21	$(2s-2p_1)$	$3s$ − 58649·3±3

TABLE 2.

CARBON IV.

Int.	λ I.Å. Vac.	ν Vac.		Term Values.
2	384·4	260166	$(2p-3d)$	$3d$ −195333±30
1	419·8	238197	$(2p-3s)$	$2p_1$−455445±100
4	1548·26	64588·6	$(2s-2p_1)$	$2p_2$−455553±100
4	1550·84	64481·2	$(2s-2p_2)$	$2s$ −520034±100
				$3s$ −217302±100

With the aid of the foregoing term values, and those which we have already published for stripped boron (B_{III}), it becomes possible to arrange tables for the stripped atoms Li_I, Be_{II}, B_{III}, C_{IV}, precisely similar to those which Pashen and Fowler have arranged for the series Na_I, Mg_{II}, Al_{III}, Si_{IV}. Such tables (3 and 4) follow.

TABLE 3.

$$(Z-s)=\sqrt{\frac{\nu \cdot n^2}{R}}.$$

(See equation 2, our paper "Some Conspicuous Successes of the Bohr Atom and a Serious Difficulty," forthcoming number *Phys. Rev.*

ν = term value.
R = Rydberg constant.
n = total quantum number.)

	$2s$.	$2p_1$.	$3d$.	$4f$.
Li . .	1·259040	1·020736	1·000437	0·999843
Be. .	2·313884	2·046944	2·001155	2·000200*
B . .	3·339489	3·064008	3·001886	3·000431
C . .	4·353908	4·074566	4·002600*	

TABLE 4.

	$2s$.	$2p_1$.	$3d$.	$4f$.
Li/1 .	43486·3	28582·5	12203·1	6856·1
Be/4 .	36719·5	28735·9	12206·5	6859·6
B/9 .	33993·1	28616·1	12207·8	6860·2
C/16 .	32502·1	28465·3	12208·3*	
R/n^2 .	27433·0	27433·0	12192·3	6858·3

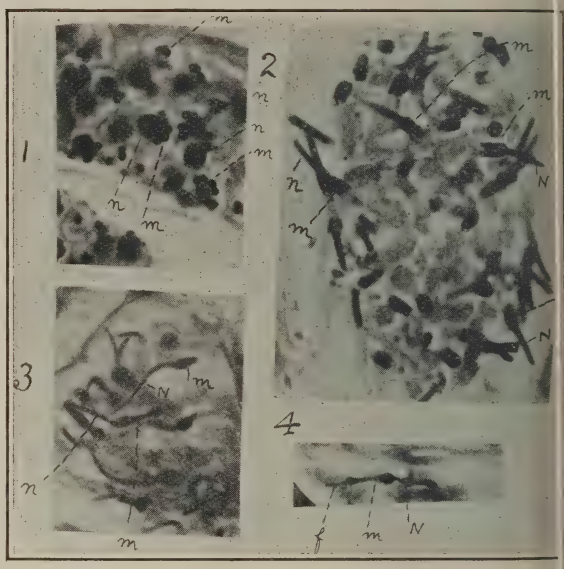
* Assumed.

R. A. MILLIKAN.
I. S. BOWEN.

Norman Bridge Laboratory of Physics,
California Institute, Pasadena, Calif., July 18.

The Scorpion Spermateleosis.

In two recent letters to NATURE (July 12 a August 2) Mr. Vishwa Nath has referred to the resu obtained by two of my students. Mr. Nath fir himself unable to support the statement of Pr Bhattacharya and myself, that in the scorpi spermateleosis "the mitochondria form the spe tail directly." It should be pointed out that t findings of Prof. Bhattacharya and myself direc



support the previous work of Prof. E. B. Wilson, t distinguished American cytologist.

So far as we are concerned, our material is ve clear and easy to study, and we feel sure that if M Nath examines his slides more carefully, he will fin that Wilson has given the correct interpretation the scorpion spermateleosis.

Herewith we give four photomicrographs of ou material. In Fig. 1 the mitochondrial spheres of th spermatids (*m*), after becoming partially fuse elongate to form a number of leaf-like structures (th mitosome, nebenkern, etc.), shown well at *mx* in Fig. The nucleus at this stage elongates rapidly (N), whi the leaf-like mitochondria further elongate to form club-shaped structure (Figs. 3 and 4) which eventuall becoming more attenuated, forms the tail as claime by Wilson. In Fig. 4 the nucleus, N, is partly out focus, but joins the mitosome at *m*, and passes bac to the axial filament (*f*), which is embraced by th residual protoplasm containing the Golgi bead.

Moreover, if the mitochondria are rejected, as Mr. Nath's letter suggests, one would expect to find evidence for this in the residual protoplasm, as has been done in pulmonate molluscs (Gatenby). If sloughing occurred at all in the spermatids overloaded with mitochondria, it could only apply to the very tail end, and certainly only after the middle piece had been formed directly from mitochondria.

Both Prof. Bhattacharya and I are hoping to demonstrate our material before the Royal Microscopical Society this winter session. We shall be very glad to see Mr. Nath there, and to witness his demonstration of tail formation in scorpion spermateleosis, by any method other than that described by Wilson and Bhattacharya and myself. Our paper on the scorpion spermatogenesis is being published in Prof. Gregoire's Jubilee Number of *La Cellule*.

With reference to Mr. Nath's observations on Miss D. King's letter on the "Oogenesis of Lithobius," I should say that Miss King has carried out her investigation under my supervision, and I have examined many of her slides. I feel sure that her account is the correct one. The scheme of oogenesis in Lithobius, worked out by Miss King, agrees with Hogben's previous researches on insect oogenesis, and broadly with my own work on Saccocirrus (Archiannelida).

Mr. Nath mentions that in "Saccocirrus (Gatenby)" the Golgi bodies undergo fatty degeneration. This is incorrect: what I did write was (*Q.J.M.S.* vol. 66, p. 15) that, "From the method and time of appearance of the fatty yolk, I believe it is formed from the Golgi bodies, but I admit it is impossible to make a trustworthy statement in such unfavourable material." The whole point of my Saccocirrus work was that the yolk is nucleolar in origin.

There is one point mentioned by Mr. Nath which is really of interest and value, provided his observations are correct, and I sincerely hope that they are. In a list of animal groups in which the mitochondria directly form the tail, Prof. Bhattacharya and I mentioned (NATURE, June 14): moths (Meves and Gatenby), cockroaches (Duesberg), Annelids (Gatenby), scorpions (Sokolow, Wilson, Gatenby, and Bhattacharya), mammals (Duesberg, Regaud, Woodger, and Gatenby, etc. etc.), and certain molluscs also (Gatenby, etc.), and now Mr. Nath states that in his centipede the mitochondria directly form the tail. This is good news to me.

In many of Miss King's Da Fano preparations we found argentophile rings on the sperms. We have not yet worked at the spermateleosis, but I am much interested to read that Mr. Nath also finds Golgi bodies on the tails of the spermatozoa of his specimens. The only spermatozoa hitherto positively known to carry Golgi elements are those of Ascaris and Cavia, but there are other more doubtful cases. It will be curious if later work shows that the argentophile rings of the centipede sperms are really Golgi bodies.

Until Mr. Nath has the opportunity of reading Miss King's full paper, which will appear about Christmas in the Proceedings of the Royal Dublin Society, I feel that further comment will not be of advantage to cytology in general. J. BRONTË GATENBY.

Trinity College, Dublin,
August 15.

Interpretations of Primitive American Decorative Art.

DR. H. O. FORBES in his communication on "Pre-Columbian Representations of the Elephant in America" in NATURE of August 2, p. 174, makes some statements on which I would like to offer comment. In his attempt to discover a basis in the Cephalopoda for the decorative *motifs* under discussion, Dr. Forbes states (p. 176) that "In the argonaut, the two central arms, when all are spread, are often so closely apposed as to appear a single very broad tentacle—a feature very conspicuous in the South Atlantic Bathypolypus." Now "central" arms can either mean the second and third of each side or possibly the first and last of both sides (the dorsal and ventral pairs). In either case Dr. Forbes's statement is inaccurate, so far as I can judge from the examination of numerous specimens and figures of Argonauta. The arms in question are not thus "closely apposed as to appear a single very broad tentacle." The statement seems to be likewise inapplicable in the case of Bathypolypus. This genus was founded in 1921 by Grimpe. It was not defined by him though he designated the type (*Octopus arcticus* Prosch). A definition prepared by myself, after correspondence with Dr. Grimpe, is in the press at the present moment. This genus includes *Octopus arcticus* Prosch, *faeroensis* Russel, *lentus* Verrill (N. Atlantic), and *grimpei* Robson (M.S.), and *valdiviæ* Thiele (S. Atlantic). It is doubtful at present what others should go into it. In any event, the two South Atlantic species have not the characters attributed by Dr. Forbes to the genus.

I may be doing Dr. Forbes an injustice. I may have overlooked in a recent fairly exhaustive search a large number of species having the character described by Dr. Forbes and transferred to Bathypolypus. If that is the case I should be very grateful for information concerning such cases.

With regard to the suggestion made by Dr. Forbes that the Maya and Copan sculptures can be interpreted as figures of highly conventionalised Cephalopods, I feel that the evidence is insufficient to sustain his theory. I admit that the Manabi slab (Dr. Forbes's letter, Fig. 1, p. 174) looks like a conventionalised squid, though I feel that careful examination would very much modify this preliminary impression (for example, if a squid, why *eight* arms? ; ? meaning of the four arms or tufts on the "mantle"; ? *circular* ends of arms). With regard to the Tikal lintel (Fig. 2) I confess that I feel a little less compromising. According to Dr. Forbes the central part of this design is a "specialised" (sic !) "argonaut or octopus" with beak and two glaring eyes, etc. I can only say that, if this is a true interpretation, then the artist has thrown the structure of his model to the winds and relied on the most generalised conception. This is no doubt very often done in highly conventionalised art, but the admission weakens any interpretation that relies on the data of realism, as Dr. Forbes does. The "superciliary ridge" from under which the eyes glare out is, according to Dr. Forbes, "the fleshy upper margin of the mollusc's mouth." In other words, the eyes and mandibles of the supposed Octopus, which are in the living animal on opposite sides of the umbrellar membrane, are not only on the same side of the latter in the Tikal lintel but the eyes are also actually placed inside the labial membrane! The structures assumed by Dr. Forbes to be sucker-bearing arms may conceivably constitute a *motif* based on these structures; but the round circles (*sc.* suckers) turn up in this design in places where it is difficult to assign them to any particular arm, so that they may be merely decorative symbols devoid of any natural basis.

While allowing a vague suggestion of a cephalopod *motif* in Fig. 2, I consider such an interpretation quite devoid of basis in Fig. 3, while in the case of the Copan Stela it is not possible to offer any serious comments, as the photographs are not good enough to enable one to form an opinion. Fig. 5 may suggest a squid, though its apical extremity is curved suspiciously like

an elephant's trunk; while one would have thought that alongside the "trunk" in Figs. 5 and 6 there were represented (in a conventionalised fashion) structures that look like tusks.

In conclusion, I should like to say that Dr. Forbes has certainly rendered a service in giving alternative explanations to some of the *motifs* of primitive American art. I do not agree that any of the figures (except possibly that of the Manabi slab) reveal a *whole* cephalopod, though parts of his Figs. 2 and 7 suggest that the arms may have been employed as incidents in larger designs. I feel, however, that unless we can obtain evidence as to the earlier stages from which this very conventionalised and, I venture to suggest, somewhat debased method of design was evolved, a Proboscidean, a Molluscan, or even a Cœlenterate interpretation will be equally plausible.

G. C. ROBSON.

British Museum (Natural History),
August 19.

On the Mercury Line λ2270 A.

IT is a remarkable fact that of the three transitions of an electron in a mercury atom represented by $1S-2p_1$, $1S-2p_2$ and $1S-2p_3$, we see optically only $1S-2p_2$ (λ2536), while the other two, namely, $1S-2p_1$ (λ2270) and $1S-2p_3$ (λ2655), have not been observed at all except by the indirect method of measuring the ionisation by impacts of electrons on atoms by Franck and Einsporn (*Zeit. f. Physik*, ii. p. 18, 1920).

In 1922, at the suggestion of Prof. N. Bohr, one of us, in conjunction with Prof. H. M. Hansen and Dr. S. Werner (Kgl. Danske Videnskab. Selskab. Math.-fys. Medd. v. 3, 1923), tried to find how to make possible the transitions from these two meta-stable states $2p_1$ and $2p_3$ to the normal state $1S$.

As a result, we found that the line λ2270 is excited in a Geissler tube when a condensed discharge is passed, whereas the line λ2655 was not detected at all.

In the present experiment, the account of which will be published later in detail, we tried to get the line λ2270, not in the spark spectrum but in the arc spectrum of mercury.

We found that the arrangement used by Messrs. Metcalfe and Venkatesachar (Proc. Roy. Soc. A, 100, p. 149, 1921; A, 105, p. 520, 1924) for the study of the absorption of mercury lines produces the line λ2270 with considerable intensity. Instead of using the long tube filled with mercury vapour as the source of absorption, we employed it for emission, and by passing a current from 2 to 3 amperes through the long tube, which we might call "a branched arc," we found that the intensity of the line λ2270 could be raised so as to come between $m=8$ and $m=9$ in the diffuse series $\nu=2p_2-md_2$. In other words, the line λ2270 appears stronger than λ2303 ($m=9$), but fainter than λ2323 ($m=8$).

Using the largest size of quartz spectrograph made by Hilger (Littrow type), and photographing in juxtaposition the line λ2270, first as excited in the above method, and second as excited in a condensed discharge, we found that the latter method of excitation gives a shift of about 0·1 A to the red side, with a faint companion line on the red side at a distance of about 0·2 A.

Similar shifts were observed for the line λ2345 ($\nu=2p_3-5s$) in the same sense, but in the opposite sense for the line λ2564 ($\nu=2p_2-4S$). The shifts are not due to the manner of projecting the image on the slit, since there are many lines which show perfect coincidence; neither does it seem likely that the shifts are due to the Doppler effect, as they remain the same when we change the polarity of the condens discharge, which was fairly well rectified.

No trace of the line λ2655 ($\nu=1S-2p_3$) w observed.

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M. FUKUDA.

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A Rotational "Fatigue" Effect of the Electric Discharge.

IN some recent experiments on the volt-ampe characteristics of low-tension discharge tubes, I utilise an "Osglim" lamp of the "beehive" variety, sealir it on to an apparatus so that air at different pressur could be introduced. (The lamp consists of an iron dis anode and a spiral cathode of thick iron wire, woun above the anode.)

It was observable at certain pressures that, whe the discharge was continuous, but failed to cov completely the cathode, the discharge shifted fro one part to the other of the cathode surface, ofte undergoing a regular cycle. At other times th motion was along the wire of the spiral, slowly bac wards and forwards through a rotation of up to 120 and even more. The rotation continued over lon periods of time in a most interesting manner.

The phenomenon is apparently an electrod "fatigue" effect. When one portion of the surfac has been serving as cathode for some time, it become "fatigued," and the value of the cathode fall potential rises; it then becomes easier for the dis charge to pass over at an adjacent portion of th cathode, and consequently the discharge rotate slowly.

That the rotation is accompanied by a correspond ing fluctuation of the voltage drop across the tub is evident from the fact that the reading of the volt meter, across the tube, rises and falls at a simila rate (there is of course a lag), and to a lesser degre variation of the current is observable.

JAMES TAYLOR.

Armstrong College, Newcastle-upon-Tyne,
August 19, 1924.

Zoological Nomenclature: Generic Names for the Official List.

THE following generic names (with genotype i parentheses) have been submitted to the Internationa Commission on Zoological Nomenclature for inclusio in the official list of generic names.

The Secretary will delay final announcement of th votes on these names until January 1, 1925, in orde to give to any zoologists, who may desire, the oppor tunity to express their opinions.

Amphibia: *Cryptobranchus* Leuck., 1821, 25 (*gigantea=alleganiensis=alleghaniensis*); *Desmognathu* Baird, 1849, 282 (*fuscus*); *Siren* Linn., 1766, addenda (*lacertina*).

Reptilia: *Alligator* Cuv., 1807, 25 (*mississipiensis*) *Calamaria* Boie, 1827, 236 (*calamaria*); *Chelydr* Schweigg., 1812, 292 (*serpentina*); *Crotalus* Linn. 1758a, 214 (*horridus*); *Dermochelys* Blainv., 1816 119 (*coriacea*); *Eremias* Wieg., 1834, 9 (*velox*) *Lacerta* Linn., 1758a, 200 (*agilis*); *Mabuya* Fitz. 1826, 23 (*sloanii*); *Phrynosoma* Wieg., 1828, 36 (*orbiculare*).

Pisces: *Blennius* Linn., 1758a, 256 (*ocellaris*) *Echeneis* Linn., 1758a, 260 (*naucrates*); *Esox* Linn. 1758a, 313 (*lucius*); *Ophidion* Linn., 1758a, 25 (*barbatum*).

C. W. STILES,
Secretary to the International Commission on Zoological Nomenclature.

Hygienic Laboratory, Washington, D.C.

Chemistry and the State.[1]

By Sir ROBERT ROBERTSON, K.B.E., F.R.S.

THE appeal of the State to chemistry has developed through the gradual recognition of the need for the application of that science to matters relating to the preservation, its currency, its financial support, its health, its food supply, its industries, and finally to academic science. In the course of this development in Great Britain, advantage has been taken, if sometimes tardily, of the general advance in chemical knowledge, and frequent recourse has been had to the advice of well-known chemists of the day, and collectively of the Royal Society; thus for various purposes the following chemists, as officials or consultants, have in the past afforded assistance in the solution of specific problems referred to them, or by taking part in Commissions: Boyle, Newton, Davy, Faraday, Daniell, Graham, Hofmann, Redwood, Abel, Roberts-Austen, Mercy, Dupré, Playfair, Frankland, Ramsay, and Dewar. It has happened in several instances that as a result of these Commissions and references to chemists, some definite chemical activity of the State has emerged. The following summary reviews the State's chemical activities before, during, and after the War.

BEFORE THE WAR.

Defence.—For the defence of the State, establishments for the production of explosives were early maintained, and when this ultimately took the form of a chemical manufacture, the Government factory took the lead in devising efficient processes, while from the various State research establishments has issued during the last fifty years an important body of original contributions to the theory of explosives and to the knowledge of their properties.

Metallurgy.—The metallurgical progress of the country has always been a concern of the State by reason of its application to defence by land and sea, and close touch has been maintained with successive developments in the manufacture and use of cast iron, wrought iron, steel, and non-ferrous alloys. While the main advances in process have been made in the great iron and steel works, material contributions to knowledge in this sphere have been made by chemists in the Government service.

Revenue.—For the revenue of the State, imposts were applied in early times, but with great uncertainty, until the charge was put on a scientific basis. Very accurate tables for the strength of alcohol were worked out under the supervision of the Royal Society at the end of the eighteenth century, to be superseded by revised ones issued only a few years ago, when, in addition, new tables were issued also by the Government Laboratory, for determining the gravity of worts before fermentation. The question of rendering alcohol unpotable, but still useful for industrial purposes, has occupied much attention. It was on account of the necessity for safeguarding the revenue that the Government Laboratory was primarily erected, although it now performs chemical work for all State Departments of Great Britain.

Health.—The three main steps with regard to public health and sanitation in this period were the forcing of these questions into prominence by Playfair, with the consequent Commissions and legislation leading to the formation of the Local Government Board and its successor, the Ministry of Health, which has many varied activities in preserving purity of air and water and protecting the workman in dangerous trades; secondly, the determination of standards for a safe water supply by the pioneering work of Frankland; and, thirdly, the appointment of public analysts by the local authorities, with the Government Laboratory as referee, for safeguarding the supply of food.

Agriculture.—Science was being applied to agriculture about the end of the eighteenth century, and at the beginning of the next, Davy did pioneering chemical work for the Board of Agriculture. Private endeavour is responsible for the next development, State action being limited to the prevention of fraud in the sale of fertilisers and feeding-stuffs. In 1909, however, the annual allocation of a sum of money to the Development Commission for the advancement of agriculture stimulated research in a large number of institutions engaged in the scientific study of problems in which chemistry plays an important part.

Other Activities.—In addition to the chemical work referred to above, there is a variety of subjects connected with State Departments to which chemists have contributed, such as the composition of the sea, and the composition and physical chemistry of rocks and building-stone. At the Government Laboratory a large number of investigations have been conducted on matters directly referred from Government Departments.

DURING THE WAR.

In all the activities described, the War requisitioned the work of the chemist, but, naturally, predominantly to meet the demands of active warfare.

Defence.—The attention that had been bestowed on the subject of propellants enabled expansion to take place with no important alteration in the technique of their manufacture, to which was adapted a new type of cordite, ultimately made on the largest scale, without using an imported solvent. For high explosives Great Britain was in much worse case, as these had not been made by Government, and were manufactured only in small quantity. Their study at Woolwich led to a rapid evolution of new processes, substances, and methods of use. Thus a method was worked out for the manufacture of trinitrotoluene, and to save this substance a new high explosive, amatol, was devised. This explosive, consisting of ammonium nitrate and trinitrotoluene, passed exhaustive trials and was ultimately produced at the rate of 4000 tons a week. The production of the ammonium nitrate for the mixture was in itself a stupendous undertaking, and the methods of filling the explosive into shell and other munitions gave rise to much ingenuity. In the Research Department, Woolwich, the number of qualified chemists engaged

[1] From the presidential address to Section B (Chemistry) of the British Association, delivered at Toronto on August 7.

in the study of explosives in all their aspects ultimately exceeded a hundred, while for manufacture and inspection more than a thousand were employed. The ideal set before himself by Lord Moulton in 1914, to produce nothing less than the maximum of explosives of which Great Britain was capable, was realised, and they assumed a quality and character that caused them to be copied by our Allies, and proved themselves more trustworthy than those of the enemy.

Starting unprepared, and without the advantage of a well-developed fine chemical industry, Great Britain was able ultimately to make a reply in the field of chemical warfare that was rapidly becoming more and more effective; at the same time, by study and often self-sacrificing experiment, protecting the soldier by the development of very efficient respirators. In this connexion and in that of explosives, nearly every professor of chemistry in the country, and many from beyond the sea, were engaged.

Metallurgy.—The enormous demand for metals for munitions and countless other war requirements led to an unprecedented concentration of the metallurgical industries on the needs of the State, and to an equal concentration of metallurgical science on investigation devoted to improvement in quality of materials for new and special war purposes. The work of the Aircraft Production Department, aided by many metallurgists and engineers, on alloy steels; of the National Physical Laboratory on aluminium alloys; and of the Metallurgical Branch of the Research Department, Woolwich, on the heat-treatment of heavy forgings and on the drawing of brass, is typical of the successful effort made in every quarter. The knowledge thus gained was disseminated in the form of specifications, instructions, and reports, and has had a great and permanent effect on manufacture.

Health.—A committee of the Royal Society had been studying food values, and was able to afford the Food Controller, when he took office, valuable data bearing on the rationing of food. The committee had dealt with subjects which shortly became of much importance, such as a better recovery of flour in milling wheat. The chemical examination of the food for the Army during the War, carried out by the Government Laboratory, employed a large staff of chemists. For the supply of many fine chemical substitutes used in medicine and surgery, formerly imported from abroad, such provisional arrangements had to be made as the organisation of a large number of university laboratories on a semi-manufacturing basis.

Agriculture.—Effects on agriculture during the War were shortage of the usual feeding-stuffs for cattle and of fertilisers. The chemists stationed at Rothamsted gave special attention to the shortage of manures and prepared instructions for the guidance of farmers; and several sources of supply of potash were exploited, including kelp, felspar, and the flue-dust of furnaces. As sulphuric acid was required for explosive work, fine grinding of phosphates and basic slag was adopted and found to be more efficient than was expected. Shortage also directed the attention of chemists to the use of little known food-stuffs, especially for cattle, and the information gained as to their feeding value was important.

Other Activities.—In many other activities in connexion with the War, chemists were directly involved, such as in affording advice on the conservation of materials, on the numerous questions arising from the operations of the War Trade Department, on the restriction of imports and exports, and on matters of contraband.

After the War.

The magnitude of the chemical effort, it can be claimed, was a factor in winning the War which must be reckoned as of importance only second to that of the bravery of our forces in the field. But it has left a lasting mark, and given to chemistry a value which were it not for the rapidity with which the achievements of science are forgotten, ought to keep before the public its connexion with almost every phase of activity.

Defence.—To take our subjects in the same order we may consider some of the effects of the energy spent on the production of munitions. The intensive study of explosives and of other chemical substances used in the War has led to a more complete knowledge of their chemistry, their physical and explosive properties, and has advanced chemical theory. These advantages are not of military importance only, but are reflected also in the production of trade explosives. The collected records of the Department of Explosive Supply afford examples of treatment of many problems of interest to the general chemical technologist, and not only to the explosives expert.

A further benefit was reaped by chemists in every position, from the professor to the youngest graduate coming into direct contact with manufacturing methods and thus gaining insight into the applications of their science. While it is true that the opportunity came to few of these to take part in the design of plant and primary choice of process, nevertheless the experience was a novel one, as it led them into the field of technology, and cannot fail to have widened their outlook. It became apparent that there was a shortage of a type of chemist which had been developed in Germany, skilled in the transference of the chemical process from the laboratory to the works scale in the largest enterprises. A chemist of this type is one who, besides having a sound knowledge of chemistry and physics, has had experience in the materials of construction used on the large scale, and in the operation of the usual types of plant for carrying out the operations of chemical manufacture, and is capable of working out flow-sheets illustrating the process, and operating plant with every regard to economy. The need for instruction in such subjects had been borne in on men like the late Lord Moulton, and as a direct result of the war-time experience of our deficiencies in this direction has arisen the movement for creating chairs of chemical engineering in some of our universities. It is to be expected that from these schools, especially where the instruction is superimposed upon a full graduate course, will come men who will lead the way in the application of academic science to industry.

Metallurgy.—While the interest of metallurgical science in war material has fortunately fallen to a peace-time level, State participation in the support of scientific research remains far greater than before the

far. In metallurgy it is exercised through the partment of Scientific and Industrial Research, with organisations of the National Physical Laboratory d the Industrial Research Associations, as, for ample, those dealing with the non-ferrous metals and th cast-iron. The State also continues to maintain icient research departments for the Fighting Services, t it is significant that the largest of these is under-king industrial metallurgical research on a con-derable scale, for the benefit of the brass and other dustries. State support and encouragement are doubtedly powerful factors in the rapid progress w taking place in every branch of metallurgical ience in Great Britain, and there is scarcely any lated industry which can fail to benefit.

Revenue.—Since the War the principal matters fecting the revenue are the higher duties, which have ndered necessary a further denaturation of alcohol. nproved facilities have been granted for the use of cohol for scientific purposes and in industry; regula-ons have been formulated for the use of power cohol, and duties have been established on imported e chemicals and synthetic dyestuffs.

Health.—The food shortage during the War directed tention to the nature and quantity of our food pplies, and led to further investigations being under-ken by the Department of Scientific and Industrial esearch on food preservation and storage. Activity also shown by the appointment of committees which re working on the subject of preservatives and colour-ng matter in food, and on the pollution of rivers by ewage and trade effluents. A great field is open in he co-operation of chemistry with medicine in the iscovery of substances suitable for the treatment f the numerous diseases now traced to parasites in he blood.

Agriculture.—So far as fertilisers are concerned, the ack of a supply of fixed nitrogen from the air which btained throughout the War has now been rectified, nd Great Britain for the first time is no longer ex-eptional among the nations by neglecting to provide tself with synthetic ammonia for agriculture and for unitions. Such war-time expedients as the use of itre-cake instead of sulphuric acid for making mmonium sulphate and superphosphate, and the ecovery of potash from flue-dust, have not survived, ut there has been a gain in the further development f "synthetic farmyard manure" and the increased se of basic slag. The present activity in research in gricultural chemistry of a fundamental character is eading to a better understanding of problems of the oil and of plant and animal nutrition, and cannot fail o be of ultimate benefit to farming.

Organised Applied Research and Assisted General Research.—Established during the War as a result of an appreciation of the contrast between the successful application of scientific method to military purposes and the want of such application to many of our manufactures, the Department of Scientific and Industrial Research has extended over a wide field. Its main activities are in the directions of State encouragement to industry to apply chemistry to its problems, of State investigation of vital problems beyond the sphere of private enterprise, and of assist-ance to workers in the purely academic field. In all these spheres activity is shown by the contributions to knowledge already forthcoming.

Personnel.

In the expansion that has occurred in the chemical sections of State Departments since the War, it is interesting to note the increase in the number of chemists that are employed. So far as can be gathered, the number of chemists working in departments maintained wholly by the State is 375 for the present year, compared with 150 in 1912, while in establishments to which the State affords partial support, such as those under the Development Commission and the Research Associations, the corresponding numbers are 150 and 50. In addition, grants are made to 145 research students and to 11 independent research workers, involving a yearly sum of about 50,000*l.*

Development of Chemistry in the Modern State.

From the foregoing account of the connexion of the Departments of State in the United Kingdom with chemistry, it is possible to trace a gradual development and ultimately a change in attitude, in passing through the stages of compulsion, expediency, and assistance.

From motives of security the State was compelled to give heed to chemical matters involved in its defence, such as those which appertained to munitions of war, including metals used in their manufacture; it was constrained to uphold the standard of its currency; and it was obliged to secure a revenue. As a consequence, the first chemical departments were set up in connexion with these activities, and from them have emanated notable additions to chemical knowledge, improvements in methods of manufacture, and specifications for Government requirements that have led to improved material becoming available for civilian use. Although mostly conducted with inadequate staff, the study of these questions, it can be claimed, proved of national advantage when the time of need arose.

In the next stage, the public conscience having been awakened by the pioneering work of Playfair, it appeared expedient to safeguard health by attention to sanitation, and, as the quality of food was unsatisfactory, to set up a chemical control. Although a start was made by Davy, a member of the Board of Agriculture of the day, progress in this subject passed to private enterprise, and a century elapsed before direct assistance was afforded to this important matter. Out of these activities come our present system of supervision over the purity of air, water and food, and also the recent progress made in the application of chemistry and physics to problems of the soil.

The last and more recent stage is in the nature of a recognition that the State is under an obligation to assist science, and in this case the science of chemistry, on which so many important industries are based. The War brought home the danger that, although the record of Great Britain as regards discovery in pure science was unrivalled, its systematic application was too often left to other countries, with the result of lamentable shortages during the War and the risk of many industries being ineffective in peace. A measure of government intervention and action appeared

requisite, and research became the business of a government department. Outside of the great firms which maintain progressive chemical staffs, the firms in numerous industries have been encouraged and assisted to co-operate in the betterment of their manufactures by the application of the methods of science, and from these associations and the organisations dealing with national problems begins to flow a stream of communications indicative of useful work accomplished. Nor is the foundation of it all neglected, for encouragement is given to workers in the academic field to follow out their ideas, whithersoever they may lead them, in accordance with the truth that "research in applied science might lead to reforms, but research in pure science leads to revolutions."

It is important to be able to record an advance in securing an interchange of information among government departments, and between their work and that of the universities, a matter which before the War was unsatisfactory, as it was mainly personal and sporadic. It is also a hopeful sign that, although the knowledge and appreciation of the methods and capabilities of science are still generally wanting, there have been signs of late years that these matters are coming to engage the attention of those who guide the policy of the State.

Centenary of the Franklin Institute.

ON March 30, 1824, the Governor of the State of Pennsylvania signed an Act incorporating the Franklin Institute for the Promotion of the Mechanic Arts. The centenary of its foundation will be observed in Philadelphia on September 17, 18, and 19, by celebrations reminiscent of the rise, growth, and continuity of purpose of a remarkable institution, now, after many inevitable vicissitudes, rooted deeply in the national life of the United States, at the same time commanding the allegiance of men of science in most other countries. Accordingly, delegates representing several of the universities of Great Britain, as well as scientific societies, will join those from Canada, France, Holland, and Germany in united expression of congratulation. To have wrested "secrets of excellent use" from Nature marks and cements the common bond.

When we direct our minds back to the Institute's initial year, 1824, it serves us to recall that here, in England, we had Sir Humphry Davy—at the height of his fame—installed as president of the Royal Society, whilst round about that period many special scientific organisations were springing into being. Among such were the Horticultural Society (1804), Geological Society (1807), Institution of Civil Engineers (1818), the Royal Geographical Society (1830) and the British Association (1831).

The Franklin Institute was established to meet the need for an institution similar to that founded in London in 1799 (the Royal Institution) by Benjamin Thompson, Count Rumford. The founders had before them, also, the history and objects of the Anderson College of Glasgow, where Dr. George Birkbeck had lectured on mechanics and applied science with inspiring zeal and successful issue. The initial tentative effort was due to two Philadelphians, Samuel V. Merrick and William H. Keating, the latter then chosen by the University of Pennsylvania to occupy a new Chair of Chemistry in its Application to Agriculture and the Mechanic Arts. They discussed a project—one of them, by the way, had been told he was wasting his time—but they were bent upon going forward. They called in two others as colleagues, and the four—all young men—using the Philadelphia Directory, selected from it the names of some 1500 citizens, inviting them by circular letter to attend a meeting on the evening of February 5, 1824, to discover and talk over plans. The meeting was a success, not a little to the surprise of its conveners, approbation of the purpose in view, namely, that of assisting the knowledge of physical science and its diffusion in the arts and sciences, being expressed freely. Later, an election of officers took place, and the promoters chose a name for their offspring. Certainly none could have been more fitting than that of "Franklin Institute," both for immediate testimony and posterity's keeping. There seems to have been no dissension. The glamour of the great "printer-philosopher" was with them in the city where he had worked, and hence homage was rendered. The original scheme prospering, in twelve months' time the corner-stone of a marble-fronted building, destined as a home, was laid (we are told "in ancient and Masonic form by the Grand Lodge of Philadelphia, in the presence of the Society") on June 8, 1825, and completed in 1826. Upon the first floor (to-day) are located the lecture room, laboratories, and offices. The second floor is occupied by the library, whilst the third is devoted to the Museum of Models and Historical Apparatus.

Membership of the Institute is open to men and women, without regard to distinction of race, nationality, or religion, the only requirements for admission being good character and interest in its work. The artisan and the professor meet within its walls upon an equal footing, and it is to this happy blending of "Science with Practice" that the particular usefulness, past and present, of the Institute must be ascribed. General meetings are held once each month, except during the summer. At these, inventions and discoveries, important engineering projects and notable achievements in all fields of scientific progress, are presented, exhibited, or discussed. Many epoch-making inventions have been shown in their experimental stages at these meetings—for example, the phonograph, electric arc, the typewriter, liquid air apparatus, and telegraphy improvement devices. The average membership for the period 1912–1922 was 1380, and in view of the greater interest now manifested in the Institute's work, special efforts are to be made towards an enlargement of its roll.

Three permanent features of the Institute's activities are the maintenance of a reference library, the holding of exhibitions, and the publication of a Journal for the diffusion of knowledge on all subjects connected with science and the useful arts. All three formed part of the original plan of the founders, and the efflux of time has added materially to their importance. We gather from a recent report referring to the library that it is,

its class, second to none in the United States, em-cing the publications of the principal scientific and hnical societies of the world. An extensive collec-n of patent literature has been brought together lispensable to inventors and manufacturers. It is rthy of mention that in 1922 the library received unique and valuable collection of books and pam-lets on windmills, inclusive of treatises on the subject nted in German and Dutch in the seventeenth and hteenth centuries, and a book of 400 views of wind-lls in all parts of the world. As a means of fostering e mechanic arts, the holding of exhibitions was very rly encouraged, and for many years kept in view. notable one was the Electrical Exhibition of 1884, ld under the direction of the Institute and by Act Congress made international in character.

The Journal of the Institute in its present form is an tavo of about 150 pages, published monthly, and it nsists in large part of reports of lectures delivered fore the Institute and its sections, together with lected original communications from specialists. ention may be made of a paper by Dr. F. W. Aston, "Atomic Weights and Isotopes," being a summary a series of lectures delivered before the Institute in 22. A series of lectures was also given in 1923 by r J. J. Thomson, on "The Electron in Chemistry." ere it is convenient to record that the Institute now blishes annually a "Year Book," which we may y is one of the most concise and distinctive issues the kind that we have seen.

Various honorary awards of medals and premiums e made by the Institute, some of which are of old anding, and highly valued, such as, for example, the lliott-Cresson, Potts, and Longstreth medals. The ost recent foundation is the Franklin gold medal (with iploma), instituted in 1914, and allotted annually to ose workers in physical science or technology, without gard to country, whose efforts, in the view of the nstitute, acting through its Committee on Science and he Arts, have done most to advance a knowledge of hysical science and its applications. The latest ecipient of this gift was Sir Ernest Rutherford.

Under new rules, adapted to modern requirements, he Institute conducts investigations, through its Committee on Science and the Arts, on the soundness and practicability of inventions, discoveries, and improvements in physical processes or devices, submitted to it. During the past twenty-five years nearly 1000 applications have received adjudication.

In 1921 the Institute received a bequest from Henry W. Bartol, a life member, of 1,208,468 dollars for research. Agreeably therewith a "Bartol Research Foundation" was established for the purpose of conducting researches relating to fundamental problems in physical science, particularly those in the field of electricity, and for the investigation of specific problems of a scientific nature which may arise in the industries. An arrangement was made to build a laboratory wherein to engage in these objects, but unfortunately up to the present nothing has reached fulfilment, owing to the high cost of building construction. It is a trust which we may be sure will eventually become operative.

The principal events of the Centenary programme comprise, on the first day, an assembly at the Franklin Institute, and an academic procession to the Walnut Street Theatre, where the Mayor of Philadelphia will deliver an address of welcome, and addresses will be given by Dr. W. C. L. Eglin, president of the Institute, and Prof. Elihu Thomson, honorary chairman of the Centenary Celebration Committee. On September 18 the chief fixture is a lecture on "The Natural and Artificial Disintegration of Elements," by Sir Ernest Rutherford. The morning of September 19 will be taken up by the unveiling of a tablet in connexion with the Bartol Research Foundation. Addresses will afterwards be given by Dr. Arthur D. Little, of Cambridge, Mass., on "The Fifth Estate," and by Prof. Jacobus, advisory engineer, the Babcock and Wilcox Co., New York City, on "Stimulation of Research and Invention." Garden parties, and fraternal hospitality in the shape of banquets to the delegates and guests, have all been provided for in unstinted fashion. A list of speakers at the sectional meetings has been drawn up. These include Sir Charles Parsons, Sir William Bragg, Prof. E. G. Coker, Prof. A. A. Michelson, Prof. Zeeman, and Prof. F. Haber.

NATURE proffers its heartiest congratulations to the Franklin Institute on the occasion of the Centenary, and its earnest hopes for future development and prosperity. T. E. J.

Current Topics and Events.

THE three hundredth anniversary of the publication of Francis Bacon's famous "De Dignitate et Augmentis Scientiarum" was fittingly celebrated at the seventy-eighth meeting of the American Association for the Advancement of Science at Cincinnati by a symposium of five papers, which have recently appeared in *Science*. Special interest attaches to the first of these by Prof. Mark H. Liddell, of Purdue University, outlining Bacon's scheme for a College of Research. His plea for the proper organisation of research is preceded by an attack on the neglect of science in the university of his day. "If any man thinks pure science an idle pursuit he fails to realise that from thence is all applied science supplied." Bacon accuses the college professor of his day of lacking in virility, and attributes this in part to the smallness and meanness of his emoluments. He also accuses the universities of their failure to produce facilities for research "in the way of laboratories, botanical gardens and other instrumentalities of investigation," and insists that "research is the intelligence department of organised knowledge," and hence must be properly financed. So Bacon comes to his own programme for the regeneration of learning by research, along two broad lines: one to provide the scientific method for the *magna instauratio*, the other the material and personnel to make it effective. The former of these he achieved in 1620 with the publication of the "Novum Organum." The second object, the provision of the College of Research (Bacon called it a College of Inventors), was never realised, but his own memorandum,

originally drafted in 1608, clearly outlines his intentions. Bacon contemplated a building equipped with libraries, laboratories, furnaces, vaults, and workshops, together with a hall of fame for statues of the great men of science, past, present, and future. There were to be rules for the conduct of studies and research, and money allowances for travelling expenses and for apparatus. There was also included a scheme for the recording of results in cipher until the time for publication was deemed appropriate. Finally, the scheme provided not only for the due rewarding of valuable research, but also for the removal of members whose work was fruitless.

ORNITHOLOGISTS have recently been hearing a good deal of the International Museum of Comparative Oology at Santa Barbara, California. We have now before us the first number of the Journal of this Museum, edited by the director, W. L. Dawson, and entitled *The Comparative Oologist*. Throughout, the claim is made that oology is an independent science of considerable importance—once indeed we are told that "Oology is the science of one half of the biologic process"; but the Journal itself enables us to see how much weight is to be attached to these claims. We will content ourselves with one passage, in which the editor informs us that the shell of a bird's egg has been formed in the ovary, "that innermost sanctuary of life"! and therefore enables us (how is not stated) to penetrate into the mysteries of "the reproductive stream itself." Numerous other quotations could be made to show that Mr. Dawson, while admirably qualified to write of generalities in a high-faluting style, appears to be unfamiliar with elementary facts concerning his special subject-matter. We wonder what men like Dr. R. Ridgway, Dr. Shufeldt, Mr. Oberholsen, or the Rev. F. Jourdain will feel when they see themselves associated with the highly original avian anatomy and physiology of the sort we have quoted. We may also quote from the rules: "Any person of scientific integrity, having attained the age of 18, who is interested in the pursuit of oology as a science *or in the collecting of birds' eggs* (italics ours) may become a 'Scientific Member' of the Museum." That is what many had supposed: now we know it. But the Museum cannot have it both ways. It can be a centre for egg-collectors, patrons of what is an amusing and interesting sport if not carried (as unfortunately sometimes happens) to the pitch of mania. Or it can be an institution for the scientific study of egg-shells, from which we may doubtless expect some, though not very much or very valuable, new knowledge. But it must not think that it can use science as a cloak for mere collecting; and that is precisely what, with its present rules and organisation, it appears to be trying to do.

THE subject of chemical apparatus and plant production generally received special consideration in the recent address of the retiring chairman (Mr. L. M. G. Fraser) of the Chemical Plant Manufacturers' Association. The improvements in the construction of plant have been along well-defined lines, the aim being to produce a better article at a lower working cost and with greater safety. Examples were given indicating lines of progress, and reference was made to (1) the more economic output of grinding machines, (2) the simplification of emulsion formation, (3) the increased usefulness of filter plant and the development of the stream line filter, (4) the distillation of special liquids with less risk and greater economy and the more efficient fractionation in still columns, (5) improved mechanical crystallisers and mixers, (6) the more thorough understanding of furnaces, and (7) the control of temperature. The better utilisation of metals and alloys and the more intimate knowledge of the action of heat on substances are regarded as factors which have helped progress. The separation of ashes from coke and unburnt coal by means of electromagnetic separators is now being carried out on a commercial scale. Recent developments in electrolytic cells were also noted, and the need for further investigation on the electrolysis of certain inorganic substances indicated. Mr. Fraser is hopeful that, with experience from similar work in other directions, plant could be properly designed to meet new needs. Many general questions bearing on plant construction were touched upon, such as the power factor in the movement of bulk materials, the study of the thermal efficiency of fuels and the interchange of heat, the general freedom from breakdown of machinery and the automatic control of operation. Improvements so far achieved have enabled many difficulties to be overcome, and future plans can be laid with greater confidence.

TWO series of coloured postcards have recently been issued by the British Museum (Natural History), one depicting the migrant bird visitors of spring, the other those of winter. A separate card is devoted to each species, and in many instances, to an excellent "close-up" view of the bird in its normal surroundings, there is added a more distant view which indicates with great success the features that catch the eye "in the field." The colouring is very faithful to life, and the artistic effect of each card delightful. Each series is offered in sets of five cards for 1s., the cards being numbered in the order in which the birds usually arrive in Great Britain. Thus the first set in the spring series contains wheatear, ring-ouzel, chiffchaff, sand martin, and swallow; and that in the winter series, snow-bunting, redwing, brambling, fieldfare, and hooded crow. Accompanying each set is a printed leaflet in which the breeding and migration habits of each species are set out. In addition to giving much pleasure to all bird-lovers, these cards should prove of great value to teachers in supplementing lessons in Nature study, especially in urban schools and in those which have not the good fortune to possess a natural history museum.

THE number of new periodicals dealing with various aspects of natural science which have been started in Japan in the last few years, is clear evidence of the attention now being given in that country to the investigation of its own natural resources; for most of the journals contain papers dealing with products occurring in Japan or which are being imported into

pan for use. One of the most interesting of these urnals is *Acta phyto-chimica*, now in its second year, hich is published by the Iwata Institute of Plant iochemistry at Tokyo, and edited by Prof. Shibata. t it have been published already a number of im- rtant papers, including those of Asahina and Fujita n anemonin, and a detailed résumé by Asahina on s work on *Evodia rutæcarpa*, which has resulted in he isolation of two new alkaloids, evodiamine and itæcarpine. The structures of these bases have een determined, and shown to be related to those of armine and harmaline, familiar to British chemists rough the work of Perkin and Robinson. No less teresting is the series of papers by Shibata and his llaborators on natural flavone colouring matters. n the current number of the journal (volume ii. o. 1), Prof. Asahina and several of his students have n important paper on the ketone of the essential oil f *Elsholtzia cristata*, Willd., which is shown to be a aran derivative, and is only the second substance of his type thus far found among the thousands of nown components of essential oils, the other being emmler's carlina oxide.

A REPORT of the administration of the Meteoro- gical Department of the Government of India in 923–24, by Sir Gilbert T. Walker, Director-General of Observatories, now retired, has recently been issued. Reference is made to retrenchment of expenditure nd to its interference with effective weather warning. The main curtailment of expenditure was effected in elegraphic charges. The issue of the Calcutta, Bombay, and Madras reports was restricted to periods of 10½, 6, and 9 months respectively, and the number of stations reporting was greatly curtailed. Four cyclonic storms were formed in the Bay and one in the Arabian Sea. In May, a severe cyclone was experienced in the Bay, in which the S.S. *Okara* was lost. The loss of this vessel has led to certain changes in the method of broadcasting important weather information, more frequent weather warnings being issued. In connexion with the upper air work, which centres round the Agra Observatory, out of 36 "instru- ment balloons" sent off during the year, there were 21 recovered. Pilot balloon work was started at Bombay and Peshawar. An extension of meteoro- graph flights is contemplated so as to obtain observa- tions to heights of 12 miles or more, and to participate in the important work undertaken in other countries. Radio weather messages are received from ships and greatly supplement the coast observations in the warning of cyclones. For the "Rainfall of India," observations are received from nearly 4000 stations. Seismological observations are recorded at several places in India and are forwarded to the Seismological Committee of the British Association.

THE *Marine Observer* for September, published by the Meteorological Office of the Air Ministry, has recently been received. It is prepared under the supervision of Captain L. A. Brooke Smith, the Marine Superintendent. The publication is essentially a vehicle for supplying to seamen valuable meteoro- logical data of interest for voyages in all navigable seas; numerous incidents are given from the meteoro- logical logs kept for the Office, and mariners are in- vited to contribute information of interest if not regular observers. The current number contains an article on "The Origin of Tropical Revolving Storms" by Capt. D. Brunt, Superintendent of the Army Meteorological Services. A large amount of wireless weather information is given, a special chapter in the issue for each month dealing with a different branch of meteorological information; the September number deals with "wind and set and drift of current." Specimen charts show currents and winds experienced in home waters, cyclone tracks are given for various oceans, a map shows recent ice in the North Atlantic, and notices are given of recent derelicts and floating wreckage. The August number contained a discus- sion on the "Hong Kong Typhoon, Aug. 18, 1923," by Commander J. Hennessy, the Nautical Senior Professional Assistant; also an article on fog by Mr. H. Keeton. A list of contents would be a useful addition to future issues.

THE first conference of Special Libraries and Information Bureaux was held on September 5-8 at High Leigh, Hoddesdon, Herts. The objects of the conference were outlined at the opening session by Dr. R. S. Hutton, director of the Non-Ferrous Metals Research Association, and Mr. J. G. Pearce, director of the Cast Iron Research Association. It has long been felt that many diverse agencies concerned with the treatment of information have problems in common, and need an opportunity to establish mutual co-operation and assistance, and to determine their relationship to the press, and to the great municipal and national libraries and other institutions. The conference, which was highly successful, provided abundant evidence of the interest in this field of work, and in order to ensure continuity of interest, without forming another association, a standing committee of the conference was appointed with power to consider matters in the interests of those engaged in directing or operating Special Libraries, and to convene a further conference at some future date. This committee is representative of a wide range of institutions, and has already held its first meeting. The most striking feature of the con- ference was the keenness displayed by a large number of highly diversified interests, including scientific, technical, industrial, wholesale and retail commerce, railways, political, agricultural, governmental, univer- sities, press, medical, sociological and banking. This diversity served to emphasise the common interest of all these agencies in receiving, treating and distributing documentary material.

THE thirty-fifth annual general meeting of the Institution of Mining Engineers will be held at the Conference Halls of the British Empire Exhibition on Thursday and Friday, October 2 and 3. Sir John Cadman will relinquish his third term of office as president on October 2, when he will be succeeded by Dr. J. S. Haldane, Director of the Mining Research Laboratory and honorary professor in the University of Birmingham.

M. MENGÈS, whose recent book was noticed briefly in NATURE of July 19, p. 85, writes to suggest that we misinterpreted him. In reply we would explain that the phrase "proposes in some measure to revert to the older 'classical' conceptions" was not intended to throw any doubt on the novelty of his ideas. It was only intended to indicate that his theory approximates more nearly to classical than to relativity theories.

AT the opening session of the annual autumn meeting of the Institute of Metals, held at the Institution of Mechanical Engineers, London, on Tuesday, September 9, Prof. T. Turner referred in his presidential address to the growing needs of the Institute in view of the steadily increasing membership, the growth of the library, and the greater use by members of the facilities which are provided. Additional funds are required if the work is to be maintained and extended; and the alternative to a further increase in the annual subscription is an endowment, the proceeds of which would be available for providing the necessary additional accommodation and assistance. Prof. Turner was able to announce a gift of 1000*l.* towards such an endowment. This donation is the largest single gift which the Institute has received, and the Council will shortly take into consideration the question as to how far, and in what manner, it may be made the basis of a larger scheme.

Two junior assistants are required by the Researc Department, Woolwich, for analytical work in co nexion with Internal Ballistics problems. Candidat must possess first-class honours in mathematic Written applications, with copies of testimonials, mu be sent to the Chief Superintendent, Researc Department, Woolwich, S.E.

WE have received from Messrs. Boots their list special research chemicals. We note that the numb of these has increased considerably, and that a gre majority of the compounds are manufactured purified in Messrs. Boots' own laboratories in Nottin ham. As manufacturers and distributors of fin chemicals, Messrs. Boots are in a position to supply, i a state of considerable purity, many of the inte mediates and raw materials which are of interest t workers engaged in chemical research.

Two useful catalogues of second-hand book offered for sale by Messrs. Bowes and Bowes, Trinit Street, Cambridge, have reached us. One (No. 422) i of a miscellaneous character dealing with works biography, sport, travel, English topography, gener literature, and of foreign origin. The other catalogu (No. 423) contains particulars of nearly 3000 work relating to mathematics, pure and applied; includin physics, astronomy, meteorology, electricity, enginee ing, assurance, insurance, etc. The catalogues ar obtainable from the publishers upon request.

Our Astronomical Column.

STATISTICS ON STELLAR VELOCITIES.—One of the chief factors in the rapid progress made in recent years regarding stellar distribution and motion has been the substitution of accurate statistical methods for the haphazard investigations of earlier times, which were often based on incomplete material. The *Astroph. Journ.*, June 1924, contains two important statistical papers by Prof. F. H. Seares.

The first deals with stellar velocities, and demonstrates the soundness of Schwarzschild's assumption that the logarithms of the tangential velocities (*i.e.* the velocities deduced from observed proper motion, after correcting for the sun's velocity), for any assigned absolute magnitude, conform very closely to the Gaussian error-curve, sometimes designated "the cocked hat." A similar conclusion is reached for the radial velocities.

The second paper seeks to find a formula for the relative numbers of stars of different absolute magnitudes. The well-known difficulty is present that the extreme dwarfs are invisible unless their distance is small, so that it is impossible to test any region except that adjacent to the sun.

Kapteyn and van Rhijn deduced the mean parallax formula $\log \pi = -0{\cdot}690 - 0{\cdot}0713m + 0{\cdot}645 \log \mu$, m being apparent magnitude and μ proper motion. This is shown to agree well with observation for stars for which M is brighter than 8 mag.; but the number of absolutely faint stars is far greater than that indicated by the formula.

The paper emphasises the urgent need of obtaining more parallaxes of these faint stars.

THE THERMOPILE USED FOR MEASURING STAR MAGNITUDES.—Allusion has already been made in this column to the use of the thermopile for measuring the total absorption by a star-image of a beam of light passed through a photographic plate. The method has the advantages of being free from personality an of giving the integrated effect of the whole imag independently of the distribution of density i different parts of it. It is thus available in reflecto plates to a considerable distance from the centre o the plates in spite of the winged character of th images. Groningen Kapteyn Lab. Publ., No. 32 contains an investigation by J. Schilt which confirm the accuracy and convenience of the method. It ha been applied to several of the Cape Phot. Durchm plates with good results, also to some plates take with the 60-inch reflector at Mount Wilson.

Stars of determined magnitudes are used fo calibrating the curves derived from the thermopil readings; these are taken from the investigations o Seares (Mount Wilson), Chapman and Melotte (Green wich), and Dziewulsky (Potsdam). It is suggeste that the method may usefully be applied to th magnitudes of stars in the Durchmusterung o selected areas.

SOLAR APEX AND VELOCITY.—*Astr. Nach.* 5312 contains a paper by B. Fessenkoff and C. Ogrodnikof on the solar apex and velocity as deduced from th radial velocities of stars of type B. This method o deducing the apex is a useful check on the method from proper motions. The latter is very sensitive t the effect of systematic errors in the older catalogues, as Kapteyn pointed out. The B stars were selected as being of high mass and small peculiar motions.

Four solutions are given, according to the assumed K effect or the shift of spectral lines arising independently of radial motion. They do not differ very largely *inter se*; in that adopted as most probable, K is taken as corresponding to an apparent recession of 3·15 km./sec. According to this, the sun is moving towards R.A. 265·8°, N. Decl. 31·9° at a speed of 21·7 km./sec.

Research Items.

ROUND BARROWS AND THE STUPA.—In the *Ceylon Journal of Science* (vol. i., part 1, section G.) Mr. A. M. Hocart argues for a connexion between the round barrows of prehistoric Europe and the stupa or tope of Indian and Cingalese Buddhism, adapting a theory of Fergusson's in the light of more recent knowledge. Fergusson, in opposing Fergusson's view, derived the stupa from the fire temple, connecting it with the solar origin to which he assigned much in Buddhism. There is, however, evidence that the stupa is essentially connected with relics, like the altar of the Roman Catholic Church, and, according to tradition, was erected over the ashes of an emperor and his family. The name *caitya* given to a tope indicates its connexion with the funeral pile, and the bo-tree invariably associated with the tope in Ceylon, to which the term *caitya* is also applied, is probably a tree planted to mark the spot of cremation. The original object of the round barrow and the stupa, therefore, appears to be identical, the fact that brick is employed in one case and earth in the other being immaterial. Further, it is possible that there may be some connexion between the round barrow and the sacred mounds of Fiji, the link being the Basarh mounds, which appear to relate to the latter through a legend of the origin of earthen mounds which, with certain modifications, is common to both.

PREHISTORIC REPRESENTATIONS OF THE HUMAN FORM FROM MALTA AND GOZO.—Dr. Zammit and Dr. Singer have contributed to the Journal of the Royal Anthropological Institute (vol. liv. pt. 1) a comprehensive study—the first to appear—of the interesting statuettes of neolithic age discovered from time to time in the megalithic structures of Malta and Gozo. The statuettes are, with three exceptions, made from local material, the majority being either of globigerina limestone or clay. In the greater number the most prominent characteristic is their obesity, sometimes, but erroneously, called steatopygia. They are classified into four groups—idealised representations, male and female, portrait models, representations of priests or temple officials, and votive offerings. The first group is that in which the obesity is most marked. The buttocks, thighs, legs, arms, and chest are enormously fat; but the head, when present, and the neck are free from fat, while the hands and feet are in all cases small. Taken in conjunction with other characters, these features suggest that a well-known pathological condition has been taken as a standard and has developed into a ritualistic convention. The figures are comparable with representations of the human form in palæolithic art, and similar figures have been described from Crete, the Cyclades, the Morea, Thessaly, Servia, Egypt, Erythrea, and elsewhere. Certain characteristics, however, separate them from all these except perhaps in the case of Thessaly. It is suggested that they may be a specialised local form, coarse and crude, of an art well known from Crete.

THE MAPPING OF OCCUPATIONAL GROUPINGS.—In a series of Norwegian studies published in the *Sociological Review* for July, Mr. A. Farquharson has made some interesting attempts to map occupational groupings in connexion with a discussion of Aandlesness and its occupations. The principle adopted in the experimental coloured map of about $\frac{1}{8}$ sq. mile of the Aandlesness promontory is based on an eightfold division of simple occupations. These are miner, woodman, hunter, shepherd, upland farmer, lowland farmer, market gardener, and fisherman. For each of these a different colour symbol is used. The derived occupations are indicated by numbers printed over the colour symbols. Thus the derived occupations from mining include smith, tinsmith, stonemason, etc., while, as regards fishing, distinctions are drawn between sea-fishing, fish-curing, and the selling of fish. This classification has the advantage of being evolutionary and indicates the link between simple and more developed occupations, but there are of course cases in which the links are not clear, and could be traced only by research in the particular case and place. In putting forward this tentative scheme, Mr. Farquharson emphasises the need of distinguishing between craft occupations, using the term in a general sense to indicate the making and growing of things; clerical employment; and intermediate occupations such as transport and distribution. The difficulties of this sociological mapping are great, but this attempt is most suggestive of the results obtainable.

VOLCANIC ISLANDS IN THE CHINA SEA.—Two new volcanic islands were reported as having appeared in the China Sea in the eruption of 1923 in approximately lat. 10° 9′ N., long. 109° E. The *Geographical Journal* for August contains a note regarding this occurrence, based on information supplied by the Admiralty. In March this year, H.M.S. *Iroquois* found that both islands had disappeared, and that their sites were covered by water of a depth of about 50 fathoms. The examination also failed to reveal any trace of the 12-fathom bank in the vicinity which had been reported at the same time as the islands. Both the islands and the shallow bank have been omitted from the charts of the China Sea, but caution is advised when navigating in the neighbourhood.

LOAD LINE (ZONES) COMMITTEE.—The report has recently been published of a Committee appointed by the Board of Trade to consider the weather conditions obtaining on the various sea routes of the world, and to advise, having regard to those conditions, to what geographical zones, and what seasons of the year, the application of the special seasonal conditions of loading prescribed by the British Tables of Freeboard may properly be extended. The procedure adopted by the Committee was in the first place to determine the geographical areas in which similar weather conditions exist, and then to study these areas in detail in order to decide what loading restrictions would be necessary. The final recommendations of the Committee are very clearly indicated in a chart of the world printed as an Appendix to the Report. In this chart are shown (*a*) the regions in which winter freeboard should obtain for the whole or part of the year, (*b*) the regions where summer freeboard should obtain for the whole year, (*c*) the regions where weather conditions are more stable than ordinary summer conditions, and in which the deeper "Indian Summer" loading should be permitted, and (*d*) the areas which are specially liable to hurricanes, with a statement in each case of the hurricane season. With regard to the hurricane areas, the Committee did not feel justified in recommending that any new restrictions should be imposed on account of hurricanes, as the number of casualties due to hurricanes, though not accurately known, is small; and in the seasons when hurricanes occur the weather conditions are otherwise favourable. The Committee strongly recommended the issue of a warning to owners and masters of ships which pass through the areas where hurricanes occur that special caution should be observed within those areas, use being made of the rapidly improving facilities for broadcasting weather warnings by wireless telegraphy.

LEFT-HANDEDNESS, STAMMER, AND SQUINT.—The modern tendency to seek for psychological causes for all ailments, whether physical or mental, finds notable expression in a recent article in the *Lancet*, where Dr. W. S. Inman, an ophthalmic surgeon, discusses the origin of squint, left-handedness, and stammer. The connexion between left-handedness and stammering has been observed before, and various attempts have been made to explain it; but always on physiological grounds. Dr. Inman's special contribution to the subject is twofold. While not denying that the causal relation is in many instances to be found in the nervous system, he abandons that line of inquiry and devotes his attention to the discovery of mental causes; and he brings in squinting as a third member of a related group. What he says, in effect, is that left-handedness, stammering, and squinting are but different ways in which the organism responds to emotional stress. The too severe exercise of parental authority in the home, for example, may give rise to left-handedness in one member of the family, to stammering in another, and to squinting in another; or two or three of these peculiarities may appear in any one member. A congenital tendency is, of course, presupposed, for it is well known that each of these defects runs in families. The important point, however, is that the family which is predisposed to any one of these defects is also predisposed to the other two: which of them will actually appear depends upon the general disposition of the person concerned. Dr. Inman thus contends that a self-reliant lad with a strain of perverseness or contrariness in his nature will become left-handed as an unconscious revolt against authority. It is the lad's way of showing that he is "again the government." Gentler natures are prone to respond to the pressure of authority, or the stress of fear, by squinting. Dr. Inman has opened out an interesting line of inquiry which may lead to important results. The cases he cites form strong presumptive evidence of the general soundness of his views.

ANIMAL PARASITOLOGY. — In a recent address (*Science*, vol. 49, pp. 306-310, 1924) on present lines of attack on animal parasitology, Prof. H. B. Ward referred to the recent rapid development of this subject, which has grown more in the last decade than in the whole previous period of recorded science. He pointed out that methods for limiting the attacks of parasites upon their hosts have outrun, in many cases, the information concerning the structure, development and bionomics of the causal organisms, and also of their transmitting agents, if any, and that therefore additional information concerning the parasites is the first necessity for further progress. He emphasised the need for the careful study of the morphology and differential characters of parasites and for examining the original specimens of a species or of material collected in the same locality and from the same host species. He remarked that problems of epidemiology are fundamentally dependent for their solution upon the correct determination of the life-cycles of the parasites concerned, and referred to the confusions which have occurred through faulty determinations. He rightly directed attention to the success of intensive studies on the parasites of lower animals, where continued observation and experimental and close control of conditions, essential for the thorough testing of the results, are possible, and he strongly advocated the closer co-operation of parasitologists and of specialists in the field of medicine.

MINERALS OF THE PRE-CAMBRIAN IN CANADA.—Dr. C. V. Corless recently read a paper before the Royal Society of Arts on the mineral wealth of the Pre-Cambrian in Canada, which is printed in t Society's Journal of August 15. He showed th the Pre-Cambrian rocks occupy an area of so 2 million square miles, and that only a very sm portion of this area, little more than the southe fringe, has been prospected. He pointed out th the Pre-Cambrian rocks in the United States conta the Lake Superior iron mines, which produce the gre bulk of the iron ores forming the basis of the va iron and steel industry of the United States, and t Michigan copper mines, which have long rank among the important producers of that metal, where the same rocks in Canada contain the Sudbury nick copper mines, the Cobalt area silver mines, and t Porcupine area gold mines, and that gold has be found widely distributed throughout a great propo tion of the Pre-Cambrian hitherto investigated. S far as geological investigations have gone, the gener character of the Pre-Cambrian rocks is, broadly speal ing, uniform, and Dr. Corless infers "that simil mineralisation would broadly follow similar geologic conditions because of the wide geological uniformit proven to exist"; he therefore asks the question "Is it not a reasonable certainty that the achiev ments of the past both in discovery and in recover of minerals in but a few per cent. of the total are will be repeated over and over again in the gre Pre-Cambrian area as a whole?" He concluded b stating that he for his part has become fully co vinced that the inference regarding the vast miner wealth of the Pre-Cambrian will be found to be tru and that intensive prospecting within this are promises to yield results of great value.

WAVE-POWER TRANSMISSION.—The Constantinesc system of wave-power transmission has been applie successfully to the synchronisation of the firing c machine-gun bullets from an aeroplane and to th Dorman Long boring machine. In his book "Sonics the inventor investigates this system, taking leakag and friction into account, and obtains a series c equations which show remarkable similarity to thos found in the investigation of long-distance telephone lines. In the *Philosophical Magazine* for July Lieut. E. A. Barclay-Smith attempts to expound th phenomena occurring in wave-power transmission an to formulate an easy method of investigating then from first principles. He also gives an indication o the line of investigation to be followed when the dat are such as will be met with in practice. The essentia feature of this system of power transmission is th production of waves in fluid contained in a pipe b means of a reciprocating plunger at one end; at th other end of the pipe is a motor plunger which i reciprocated by the pressure waves in the liquid. Th pipe may have several branches leading to differen plungers so that power may be received by severa machines. The author first investigates a single pip full of fluid when a plunger starts to reciprocate at on end and neglects friction and leakage, and he show that there is created a series of pressure-waves, eac accompanied by its corresponding particle-velocit wave and travelling to and fro along the pipe, and h explains how the conditions at any point may b ascertained if those existing at some other point ar known. Inertias and hydraulic capacities are the considered, the latter being of two different kinds Then follows an investigation of the simplest practica case, namely, a generator and motor at either end o a uniform pipe. Three cases are examined: (*a* The motor piston is fixed; (*b*) the motor piston i oscillating but absorbing no power; (*c*) the motor i absorbing power. The contents of the paper ar valuable, but will require considerable amplificatio before they can be of service to the practical designe

Germination of Seeds exposed to Low Temperatures.

By H. F. ROBERTS, University of Manitoba.

THIS investigation was undertaken in December 1921. Seeds of thirty species were placed in containers (druggists' ointment tins), one lot being left indoors in the laboratory, at a temperature of 75° F., the other lot being exposed out of doors, for 83 days, from January 9 to April 2. In both cases the seeds were kept perfectly dry. After the conclusion of the period indicated, the seeds of both lots were germinated between blotters for 10 days in the laboratory, at a temperature of 72°-75° F. One hundred seeds were tested from each lot, the germinated seeds being counted on the fifth, seventh, and tenth days. Fifteen varieties of garden seeds, belonging to seven species, gave a germination percentage at the end of 10 days of 67 per cent. to 61 per cent. in favour of the indoor lots. For eleven varieties, belonging to eight species, the germination percentage at the end of 10 days was as 70 per cent. to 66 per cent., also in favour of the indoor lots. The twenty-six varieties gave an average percentage germination at the end of 5, 7, and 10 days of 42 : 36, 61 : 58, and 69 : 65 respectively, for the indoor and the outdoor lots, or a preponderant percentage superiority of 6 per cent., 4 per cent., and 4 per cent. respectively, for the three successive periods, in favour of the lots kept indoors.

From the above summary, it appears that a small average increased germination percentage occurred in the case of seeds kept at laboratory temperature. It was noticed that the seeds of cool temperate species developed a germination percentage higher by 25 per cent. (54 : 20) than those of the warm temperate species kept at laboratory temperature, during the first 5 days of the germination period, although the increased percentage was but 14 per cent. (43 : 29) in favour of the same group exposed to the outside winter temperature. The total germination percentage, however, was approximately the same in both cases.

The mean temperature out of doors for the period of the experiment was as follows, in degrees Fahrenheit: Jan. +3·0, Feb. +0·4, Mar. +24·7, Apr. +41·5, May 60·0.

In the winter of 1923, another lot, consisting of fourteen species, in thirty-three varieties, all of them cool temperate vegetable and field seeds, were exposed as before on January 26. On May 12 the different lots of seeds were tested for percentage of germination. In the preceding year's experiment the germination test was made in the laboratory for plant physiology of the University of Manitoba. In the second year the germination tests were conducted in the official Dominion Seed Laboratory at Winnipeg. The results obtained were as follows: As the average of the summary shows, there was a difference of 4 per cent. in favour of the seeds kept at laboratory temperature,—about 2 per cent. less than the average at the end of 10 days for the twenty-six species and varieties tested the preceding year. At all events, the results, although not conclusive, at least point to a slight diminution in total vitality, as the result of continued exposure to low winter temperatures at the latitude of Manitoba. It should be stated that all the seeds tested were in a thoroughly air-dry condition before the beginning of the test.

Sixty-six varieties, belonging to fifteen species, were tested, including carrot, Swedish turnip, mangel, sugar beet, barley, flax, crimson and white clover, cucumber, cauliflower, celery, egg plant, and cabbage. The total averages for all varieties tested were as follows:

	4-day test.	10-day test.
Inside . . .	56	73
Outside . . .	57	75

There is therefore seen to be practically no difference in the results as between the seeds kept indoors and those kept outside. If some of the individual cases are examined separately, three varieties of carrots gave at the final test 69 per cent. and 68 per cent. respectively for the seeds outside and inside; six varieties of Swedish turnip, 75 per cent. and 75 per cent.; three varieties of mangels, 56 per cent. and 62 per cent.; three varieties of turnip, 71 per cent. and 73 per cent.; three varieties of cucumber, 79 per cent. and 81 per cent.; four varieties of cabbage, 98 per cent. and 77 per cent.

It thus appears, when the details can be taken in numbers sufficient to indicate an average result, that the data agree with the general average. Inasmuch as the data herein are at variance with the general experience of practical men, horticulturists, etc., with regard to the practical utility of chilling seeds, it is concluded that the general factor of moisture is the effective one, and that the layering of seeds in a moist substratum accounts for the effectiveness of the practice, rather than the temperature factor alone.

Barogram Analysis in Weather Forecasting.

THE Italian meteorologist, Francesco Vercelli, has made a laborious study of barographic records from various parts of the world, and various periods and seasons, submitting these curves to a process of periodigram analysis on the lines familiar in tidal investigations, or as applied to the study of seiches in lakes by the late Prof. Chrystal. The results are described in full detail in a booklet published last year in Rome, under the auspices of the Geophysical Institute of Trieste, entitled "Nuovi esperimenti di previsioni meteorologiche."

From the generalised point of view, the barometric curves are shown to contain the well-known diurnal period which is so outstanding in the tropics, various periods ranging between a few days and a month, and an annual period, together with a small "insoluble residue," representing what must be regarded as irregular fluctuations. The amplitudes of these several periods, and other characteristics thereof, differ greatly according to latitude, season, and continentality. If the periodal composition of a given barogram is known, it becomes possible to synthesise its prolongation on the assumption that none of the contained periods die out or others reappear, and thus to make a forecast of the course of barometric pressure for a longer period than is possible by the ordinary synoptic chart method.

Vercelli claims—and the responsibility for the statement must rest with him—to have obtained remarkably good agreement between the predicted and actual continuations of his curves, and to have used this method of weather forecasting with much success in circumstances of grave responsibility on the Italian Front during the War. He indicates the main source of error to be the liability to cessation, or temporary suspension, of any of the component periods, or the reappearance of others. He also points out that the paper in question, discussing the analysis of

single curves, is only the commencement of the subject, since the next step will consist in co-ordinating the analyses of curves from several places; this would greatly enhance the usefulness of this method of forecasting.

The author does not, however, appear to lay enough stress on the fact that forecasting pressure is by no means equivalent to forecasting weather, and that the correlation between rainfall and the height of the barometer at a place, or even the connexion between rainfall and pressure distribution over an area, is none too close from a forecaster's point of view. One has also to consider the tendency of the weather to get into dry or wet "grooves"; for it is well known that during pronouncedly wet spells, downpours occur in passing barometric configurations that would scarcely yield a drop during a dry spell. Moreover, it does not follow that Vercelli's method, even if found practicable in Italy, would answer in England, where it is possible that the relationship between pressure and weather may be rather more complex. It is just such climatic peculiarities we want to discover, and it is not too much to say that even if a universal application of Vercelli's system to weather forecasting proved wholly unserviceable, which is scarcely likely, it could not fail to bring to light any such interesting climatological differences between one region and another. L. C. W. BONACINA.

Wind, Wave, and Swell on the North Atlantic Ocean.[1]

DURING a voyage from Southampton to Trinidad and back by R.M.S. *Oruba* the period of the waves was taken several times daily, and from this their speed was calculated. The speed of the wind was ascertained by means of a Robinson anemometer (lent by the Meteorological Office), due allowance being made for the speed of the ship and the direction of the wind.

The water is very deep from a short distance beyond Ushant, and free from strong currents so far as Barbados. The speed of the wind ranged from 13·9 to 23·6 statute miles per hour. That of the waves was in all cases less, the difference ranging from 1·0 mile an hour to a little more than 8·0 miles an hour. The latter is sufficient to keep a light flag flying. Anything less than 1 mile an hour is reckoned a calm. The difference was not proportional to the speed of the wind; nevertheless a relationship emerges when account is taken of the observations which were made simultaneously of the swell of the sea. When swell and wave ran precisely in the same direction (as sometimes occurred in the region of the Trade winds) and on one day when no swell was recorded, the speed of the wave was so nearly equal to that of the wind that the breeze blowing over the ridges was only equal to the "light air" which barely suffices to give steerage way to a fishing smack. Such a light air would be detected on land by drift of smoke but would not move a wind-vane. Thus there was no longer a battle between wind and wave.

When the swell followed but crossed the wave the difference in speed of wind and wave was greater, and this difference increased rapidly when the crossing swelling swell was meeting, instead of following, the wave. When the waves were much slower than the wind their height was always small, and sometimes their fronts were short and irregular. It was evident that the growth of waves in both length and height was much hindered by a crossing swell, and it ca be safely inferred that the general absence of swell a sufficient reason for the rapid rise of waves upo enclosed seas. When a wind comes on to blow in th direction of the ocean swell with a speed greater tha that of the swell, the growth of large, steep waves very rapid (doubtless even more rapid than the growth from smooth water), but this occurrence relatively rare in the North Atlantic.

The direction of the breaker out at sea was foun to be intermediate between that of wave and swe (the breaker being formed when they override), s that the practice of observing the direction of "th curl on the water" as a method of determining th direction of the wind gives an erroneous result whe ever there is a crossing swell, which is the usu condition upon the oceans. The general run of th waves, on the contrary, gives a trustworthy indicatio of the direction of the wind.

[1] Substance of a paper by Dr. Vaughan Cornish read before Section E (Geography) of the British Association at Toronto on August 8.

Mountain Structure.

THE origin of mountains continues one of the mos controverted problems in geology, because geo logical maps of mountain areas are most difficult t prepare, and the interpretation of mountain structur involves appeal to layers of the crust far too deep fo direct observation. The American Geological Societ has arranged a symposium of nine papers on th development of mountains,[1] which is the best availabl summary of modern opinion on the subject an illustrates its diversity.

The series opens by a masterly sketch by Pro Schuchert of the development of research on orogen from its foundation by H. H. Rogers, and of th evolution of North America, illustrated by 17 map He compares the American school with Haug's vie of geosynclinals, which he rejects as untenabl Amongst several useful new terms proposed "tafrogenesis" for rift valley formation.

Mr. Longwell's paper on Kober's theory is appro priate, as it deals with an extension of the subsidin belt explanation of mountain formation. Kobe reclassifies the Alpine elements to avoid that asym metry in mountain chains which Suess emphasised a their distinctive feature. Prof. Hobbs rejects Suess' arrangement of the Asiatic arcs, and assigns many c them to a direction of movement opposite to tha adopted by Suess.

The structure of Appalachia naturally plays a larg part in the symposium, and is discussed by J. E Woodworth and Arthur Keith, whose conclusions ar opposite. The former adopts isostasy, which Keitl criticises adversely. He attributes the Appalachian to the intrusions of many granitic batholiths; in valuable discussion of rival theories he rejects th shrinkage of the earth, owing to the astronomica disallowance of the necessary reduction in size; bu if the geological evidence for the contracting earth i adequate the astronomers will doubtless find som reconciliation of that fact and their calculations.

The structure and building of the Rocky Mountain is discussed by G. R. Mansfield and W. T. Lee, whos paper is accompanied by appendices by C. E. Va Ostrand and W. D. Lambert. Mansfield reject Kober's view that rift valleys are accompanied b compression, and insists that they are due to tension Lee describes the Southern Rocky Mountains as du to vertical uplift in the restoration of isostati equilibrium.

[1] Symposium on the Structure and History of Mountains and the Cause of their Development. Bull. Geol. Soc. Amer., Vol. 34, Pt. 2, June 3 1923, pp. 151-380, 1 pl.

University and Educational Intelligence.

CAMBRIDGE.—As was reported some months ago, the Rockefeller Trustees offered to build a School of Pathology for the University, and to endow it shortly, if the University could provide from other sources the sum of 33,000*l.* as a share of the total expense involved. It is now announced that Mr. Ernest Gates, of Norfolk, has offered the sum necessary to complete the 33,000*l.*, and is thus enabling the University to accept the generous offer of the Rockefeller Trustees.

LONDON.—A course of 24 university extension lectures on "The History of Science" will be given at Gresham College, Basinghall Street, E.C., by Dr. C. Singer, beginning on September 29. The first lecture will be free. A course of instruction in geography has been arranged for delivery at the Westminster Training College, Horseferry Road, S.W., for one year full-time students and four year part-time students. Particulars of these and other courses of lectures on science, geography, history, literature, economics, art, etc., may be had from the Registrar, University Extension Board, University of London, South Kensington, S.W.7.

MANCHESTER.—In connexion with the department of Bacteriology and Preventive Medicine, a diploma in bacteriology has been instituted and a course of instruction for graduates in medicine or in science will be started in October. It is requested that intending candidates for the diploma shall send their names to the director of the Public Health Laboratory, York Place, Manchester, from whom further particulars can be obtained.

OXFORD.—Applications are invited for two research assistantships in the Institute of Agricultural Engineering. Candidates must have had specialised training and experience in advanced physics and electrical engineering respectively. Particulars and application forms are obtainable from the Director of the Institute, 65 St. Giles', Oxford.

UNIVERSITY COLLEGE, Reading, and the Berkshire Agricultural Instruction Committee invite applications, up to September 29, for the post of Instructor in Beekeeping for Berkshire. Particulars may be had from the Agricultural Organiser for Berkshire, University College, Reading.

APPLICATIONS are invited for the professorship of Electrotechnics in the University of the Witwatersrand, Johannesburg. Particulars of the position and form of application are obtainable from the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2. Applications for the post and copies of testimonials must be sent to the Secretary by, at latest, September 30.

THE Educational Directory, 1924, published by the United States Bureau of Education, containing some 15,000 names and costing only 20 cents, must be invaluable to educationists in the United States, and is not without interest in other countries. The names given are those of presidents, deans, superintendents, and other administrative officers, and there are useful lists of boards and foundations, libraries, associations, and periodicals. The extent to which the summer school system has developed in America is indicated by a list of nearly 900 summer schools.

Early Science at the Royal Society.

September 13, 1666. The Society being taken up for the most part of this meeting with the consideration of the place for their future meetings in that time of public disorder and unsettlement by reason of the late fire, was thereby hindered from making experiments, and discoursing of philosophical subjects, as they used to do.

1677. Ordered, that Mr. Boyle, Sir John Hoskyns, and Mr. Hill, or any two of them do at ten of the clock in the morning go to the widow of Mr. Oldenburg, late secretary of the Society, and demand, receive, or take order for securing, for the use of the Society, all such goods, books, and writings belonging to the Society, as were or had been in the possession of her, or of her late husband.

September 14, 1663. Mr. Oldenburg mentioned, that Mr. Beal was willing to engage in the observation of the weather, and in registering the changes thereof; and that he hoped to set the same at work in other parts of the country; desiring to be furnished with thermometers of the same figure and size. Whereupon Mr. Hooke was ordered to give the operator directions to provide a dozen sealed thermometers with spirit of wine, to be sent to Mr. Beal, and into other parts of the world.

1664. An account was given by the president of some experiments made on the top of St. Paul's steeple: 1. To measure the vibration of a pendulum of 200 feet long. 2. To discover the difference of the weight of bodies on the top of the steeple and below. 3. A repetition of the Torricellian experiment.

September 17, 1662. Sir Robert Moray mentioned a French gentleman, who having been some time in England, and being present at a meeting of the Society, took notice, that the nature of all trees is to run altogether to wood; which was changed by a certain method of cutting them, whereby they were made, contrary to their nature to bear fruit; and that according as this cutting was performed with more or less skill, the more or less fruitful the tree would be. A proposition was offered by Sir Robert Moray about the planting of timber in England, and the preserving of what was then growing.—Dr. Charlton read his discourse entituled "Apparatus Phonocampticus: or what inquiries are principally to be made by such, who would attain to the certain knowledge of the nature of echos," which was ordered to be entered into the book of histories and theories.

September 18, 1661. Mr. Croune produced two experiments, one of the compression of the air with quicksilver in a crooked tube of glass, the nipt end of which broke; and the other with a cork kept down at the bottom of a cylinder of water in a vessel perforated at the bottom, over which the cork was laid; upon stopping of which foramen, and the pouring in of water, the cork immediately rose.—Mr. Boyle gave an account of his having made the former of these experiments by compressing twelve inches of air to three inches, with about an hundred inches of quicksilver.

1666. Mr. Hooke showed his model for rebuilding the city to the society, who were well pleased with it; and Sir John Laurence, late lord mayor of London, having addressed himself to the society, and expressed the present lord mayor's and aldermen's approbation of the said model, and their desire that it might be shown to the King, the president answered, that the society would be very glad, if they or any of their members could do any service for the good of the city; and that Mr. Hooke should wait on them with his model to the King, if they thought fit to present it; which was accepted with expressions of thanks.

Societies and Academies.

PARIS.

Academy of Sciences, August 18.—M. Guillaume Bigourdan in the chair. Notice of the death of J. B. de Toni, Correspondant in the section of botany.—F. E. **Fournier**: Remarks on the interpretations to be given in future to the three special signals defined in the author's note on safety manœuvres for steamships passing each other in fog, published in the *Comptes rendus*, August 4.—S. **Winogradsky**: The microscopic study of the soil. A detailed description of the technique adopted for the direct observation of the soil bacteria, together with a short account of the results obtained.—E. **Mathias**: The noise of the lightning flash. The theory is propounded that the electrical discharge produces endothermic compounds of oxygen and nitrogen of the type O_4, N_4, O_6, N_6 and that the noise of the flash is produced by the explosive decomposition of these substances. According to this theory the flash and noise are not produced simultaneously. No experimental evidence in support of the theory is given.—Charles **Nicolle**: Contribution to the knowledge of obscure infections. Examples drawn from the experimental study of exanthematic typhus. The term *infection inapparentes* is given to a type of acute septicæmic infection, existing exceptionally in the guinea-pig and frequently in the rat. There is no rise of temperature, and the existence of the disease can only be recognised by inoculation into other animals: the condition is quite distinct from what has been termed latent infection.—H. **Mineur**: The analytical theory of continued finite groups.—M. **Paschoud**: The problem of uniform regime in a fine tube the section of which is an isosceles right-angled triangle.—Carl A. **Garabedian**: Four methods for solving the problem of the rectangular beam.—Antonio **Cabreira**: The determination of geographical latitude, any three altitudes and the declination of the star being known.—Ernest **Esclangon**: The total eclipse of the moon of August 14, observed at the Strasbourg Observatory.—L. **Dunoyer** and P. **Toulon**: Some electro-mechanical applications of arc relays with external sheath.—Carl **Benedicks**: Method for the determination of the density of iron and of other refractory metals in the liquid state: an extension of the hydrostatic method of Dulong and Petit. The density of liquid iron at 1540° C. was found to be $6{\cdot}92 \pm {\cdot}07$.—C. **Gutton** and G. **Laville**: Electrometric measurements of very small alternating potential differences.—R. **Bureau** and A. **Viant**: Meteorological conditions and the appearance of certain atmospheric disturbances in receiving apparatus of wireless telegraphy. Atmospherics are always connected with invasions of polar air and are removed by the arrival of a warm front.—André **Graire**: The reversibility of the reactions of sulphuric acid formation in leaden chambers. Evidence of the reduction of sulphuric acid to sulphur dioxide by nitric oxide, reversing the ordinary reaction forming sulphuric acid in the leaden chamber.—Mme. Pauline **Ramart**: Molecular transpositions. Identification of the products of dehydration of 1.1.3-triphenyl—2.2-dimethyl—1-propanol.—H. **Gault** and B. C. **Mukerji**: The formation of hydrocellulose.—G. **Vavon** and A. **Couderc**: The isomerism of menthol and neomenthol. The addition of hydrogen to menthone, in the presence of platinum black, gives a mixture of stereoisomers in which neomenthol (cis) predominates over ordinary menthol (trans).—R. **Fosse**, Ph. **Hagene**, and R. **Dubois**: Researches on a new method of quantitative analysis of cyanamide in its calcium compound.—P. **Nottin**: The estimation of maltose in the presence of other redu sugars by means of Barfoed's solution.—A **Schoep**: Sklodowskite, a new radioactive min This was found in the Belgian Congo, in a layer taining several uranium minerals. Its composi is $MgO \cdot 2UO_3 \cdot 2SiO_2 \cdot 7H_2O$ and it has tellurium, ni and alkalies as impurities.—R. **Verneau**: Re prehistoric discoveries in Indo-China. These dep were found in caves in the Bac-Son limestone ma and have furnished several thousands of s implements.—L. **Blaringhem**: The degenerescc of flax.—L. **Emberger**: Contribution to the st of the formation of plasts in plants.—G. **Ram** The properties of diphtheric anatoxine. The toxine, the preparation of which was describe an earlier communication, retains its immuni properties for long periods (twelve months) if in an ice box (3° to 4° C.). Keeping does not dev any toxicity, and the properties are unchanged a heating to 65°-70° C. for one hour.—— **Simion** and André **Lancien**: The influence of the cinna radicle on the stimulation of the hæmatopoi organs.

Official Publications Received.

Agricultural Experiment Station, Michigan Agricultural Col Special Bulletin No. 125: Michigan Potato Diseases. By G. H. C and J. E. Kotila. Pp. 55. Special Bulletin No. 129: Bean Growi Michigan. By J. F. Cox and H. R. Pettigrove. Pp. 21. Special Bul No. 130: The Clovers and Clover Seed Production in Michigan. By Cox and C. R. Megee. Pp. 23. Special Bulletin No. 131: Tomato G ing in Michigan. By E. P. Lewis. Pp. 14. Special Bulletin No. Common Pests of Field and Garden Crops. By R. H. Pettit. Pp Technical Bulletin No. 63: Studies on Michigan Celery Diseases. Study of the Early Blight Fungus, *Cercospora apii* Fres. By L. J. K Pp. 43. Circular Bulletin No. 62: The Simplex Lime Spreader. H. H. Musselman. Pp. 7. (East Lansing, Mich.)

Proceedings of the Aristotelian Society. New Series, Vol. 24: taining the Papers read before the Society during the Forty-fifth Ses 1923–1924. Pp. ii+272. (London: Williams and Norgate.) 25s. net

University Correspondence College. London University Guide University Correspondence College Calendar, 1924–1925. Pp. 204. (bridge: Burlington House; London: 34 Red Lion Square, W. Gratis.

A Catalogue of Scientific Periodicals in Canadian Libraries. Prep by Dr. Gerhard R. Lomer and Margaret S. Mackay. Pp. xx+ (Montreal: McGill University.)

Diary of Societies.

MONDAY, SEPTEMBER 15.

CONFERENCE OF ENGINEERING SOCIETIES (at the British Empire Exhibiti at 10.30.—Miss C. Griff: The Working of Stainless Steel.—A. R. P Co-operation between the Works Chemist and the Engineer.—T. Hunter: Ceylon Plumbago—Its Uses and High Qualities.—A. S. Ackermann: Technical Popular Fallacies.

TUESDAY, SEPTEMBER 16.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. C. Saleeby: Light and Life.

THURSDAY, SEPTEMBER 18.

CERAMIC SOCIETY (Refractory Materials Section) (at the British Em Exhibition).—T. W. Barley: A Comparison of Gas and Coke F Drying Stoves, together with a Description of the Construction Operation of the Hüttenes Coke-Fired Air-Blown Furnace.—Prof. J. Cobb and H. S. Houldsworth: Some Properties of Clay Silima Mixtures.—W. Hugill and W. J. Rees: The Influence of Exposure the Chemical and Physical Properties of Certain Fireclays.— Vernadsky: The Action of Heat on Kaolinite and Kaolinitic Clays.— J. Rees: Alumina-Silica Minerals in Firebricks.—Dr. J. W. Mellor A. Scott: The Action of Heat on Kaolinite and other Clays, Part II A. Scott: The Origin of the Austrian Magnesite Deposits.—A. Haddi X-ray Investigation of Clays and other Ceramic Substances: Researc into the Application and Practical Value of the Method.—W. J. Re Note on the Storage of Silica Refractories.—W. J. Rees: The T Specific Gravity and After Expansion of Lime-bonded Silica Bricks W. Hugill and W. J. Rees: A Rapid Method for the Determinatio True (or Powder) Specific Gravity.

FRIDAY, SEPTEMBER 19.

CERAMIC SOCIETY (Refractory Materials Section) (at the British Emp Exhibition.—(For Papers to be communicated see above.)

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—*Red Book* Ni (Affiliation of Photographic Societies with the Royal Photograp Society). The slides selected from the Affiliation lantern slide co petition will be shown on the screen, and a criticism on the slides w be made by S. L. Coulthurst.

Supplement to NATURE

No. 2863 SEPTEMBER 13, 1924

The History of Scientific Thought.

By W. C. Dampier Whetham, F.R.S.

THE earliest form of history is a chronicle of priests and kings with their attendant worshippers and warriors. The misty dream of godascended heroes passes into the clear vision of the lered march of Roman legions; the picturesque geant of medieval bishops and barons vanishes in e smoke of Bosworth field; and the sound of Drake's ns, drumming the Spaniards up the Channel, melts o the strains of a Te Deum, sung in Notre Dame f another victory over Marlborough.

Then Clio discovers politics, and tells us of statesmen d of constitutions. Pericles and Cicero, Richelieu d Walpole, Magna Charta and the Petition of Right, e Declaration of Independence and the French evolution (with appropriate footnotes on contemrary literature and art), are acclaimed as the proper udy of mankind. The old idea of a Garden of Eden a golden age of heroic kings in the past changes into e equally pathetic delusion of certain and continued ogress in the future, necessarily linked with the owth of political democracy in the present.

So historians taught when our fathers were young. hen came Thorold Rogers and William Cunningham, ho first saw the importance of economic history, hile Maitland was putting new life into the chronicles Law and Constitution by the study of records. nderlying the froth and glitter of politics and war, e were shown the deep and steady currents of economic hange. Control of the trade routes of the ancient orld, the rise of European prices due to the gold of lexico and Peru, the coal of England burning into ower in the pioneer factories of the world, were realised s more mighty than the beauty of Helen or the valour f Achilles, the will of Popes or the ambition of Kings, he genius of Napoleon or the lure of Reform Bills. nd the believers in sudden Utopias, disillusioned by his time of political reform, hastened to become conomic socialists.

But now men begin to ask how these resistless urrents of economic change are started, and what letermines the channels in which they flow. It is lear that our varying control over the resources of Nature is one factor involved. When bronze could be sed instead of stone and flint, when fresh-forged iron replaced the softer bronze, new industries appeared, and the efforts of men were perforce turned aside to develop and exploit them. The making of gunpowder pierced the knight's bright armour and levelled the baron's frowning walls, to spread abroad the King's peace and liberate the trade of towns. Tull's discoveries in the art of growing field-crops, and Bakewell's study of the methods of stock-breeding, gave food for the rapidly growing population, called into being by the energy of coal, converted in the factories built to meet the inventions of Watt and of Arkwright.

This harnessing of Nature's fiery steeds of power is one of the two functions of that ordered knowledge we call science, and, conversely, the material wants of man give one of the two motives from which pure as well as practical science springs. Geometry arose from the need for the repeated mensuration of land after the yearly flood of the Nile; astronomy began as the bye-play of Chaldean astrologers, seeking, by the dim light of the stars, to peer into the future and thus control the destinies of man; thermodynamics was developed to explain and improve the working of the steam-engine.

But another desire is also at work to generate science, and another function is fulfilled by science when born. Man does not live by bread alone. The longing of the soul for light, of the brain for knowledge, is a nobler if a rarer instinct than the craving of the body for food and shelter. The mystery of existence, the eternal riddle of the Sphinx, moves the mind of the philosopher, and, when he learns to humble his hopes and advance step by step on the slow road of observation and experiment, he becomes a man of science and gains an ever-increasing insight into the secrets of Nature.

So it is that history, to become a complete record of man's story, must take account of his intellectual as well as of his material achievement. Thus alone, when the history of thought is combined with that of action, can we watch in its fulness the great human drama, and write in worthy form a Universal History of the World.

Moreover, to do this as it should be done, we must call to our aid the transforming magic of literature. Our poets must not only sing of burning Sappho or the hills of Rome, of Ivry or of Waterloo, of fights for

freedom or of legal progress broadening down from precedent to precedent. They must tell us also of Newton and of Einstein; of the busy laboratory and the mountain observatory; of the spiral nebula whirling from its arms new stars into the dark abyss of space, and the hundred million years of organic evolution; of the lion-haunted dreams of early cave-men, the rise and fall of succeeding civilisations in the long history of the world, and the majestic march of modern knowledge—perhaps but starting on an illimitable progress towards the moral and material betterment of all mankind, perhaps doomed to check and dissolve once more amid the social and economic dangers of our great democratic experiment. There is romance enough in the story of the past, in the veiled mystery of the future, to give a theme worthy of Shakespeare or of Sophocles.

This vision of science as the uniting link between the intellectual and the practical efforts of man, the worthy subject of history and of literature—a vision hitherto seen by few—is at length becoming clear to many. Darwin fluttered some ecclesiastical dovecots; but now for thirty years a cumulative series of striking discoveries has awakened the imagination of all educated men. Röntgen's X-rays, the sub-atomic electron of Thomson, the radioactive disintegration of matter revealed by Rutherford, are paralleled on the biological side by the tracing of the source of malaria, the detection of vitamins, and the application of Mendel's researches to the breeding of new varieties of cereal crops. The War enforced the lesson. Victory was impossible without the aid of the physicist, the chemist, the biologist, and the engineer; and peace cannot bring prosperity and contentment until the electrician has led power about the land, and the economist taught us how best to use and distribute its products.

We see, therefore, a great quickening of interest, not only in contemporary science and its possible applications, but also in the story of scientific development in the past and in the lives of those who have made it. We need but turn over the pages of NATURE for the last few years to see what a change has taken place. Book after book has recently appeared dealing with some aspect of this wide subject, and NATURE itself has helped, both by notices in its editorial columns and by such serial publications as the Calendars of Scientific and Industrial Pioneers and the abstracts of Early Science at the Royal Society.

The universities and schools also are showing more interest in this aspect of science. Mr. R. T. Gunther, led by a chance finding of a collection of apparatus "locked up in a dark cupboard in Christchurch, all smothered with the dust of ages," is publishing a series of studies of early science at Oxford, and Dr. and M Singer carried on notable research there on the histo of science, especially on the biological and medical sic before they moved to London, where a Universi course of study in the history, principles, and metho of science, leading to an M.Sc. degree, has been esta lished. Sir Clifford Allbutt gives occasional lectur at Cambridge on the history of medicine, and S Arthur Shipley on the development of biology.

In schools, nearly all boys now learn some scienc and, both for those who are specialising in it and f those whose main intellectual interests lie in other fiel of thought, it is well to gain some knowledge of t course of its growth, even to read some of its classic writings. The reports of the yearly conferences schoolmasters show an increasing appreciation of t advantages of this mode of treatment.

Education is searching for a way of presenting t new humanism. When the works of the writers Greece were rediscovered at the Renaissance, they we welcomed, not only as history and literature, but al as containing philosophy and science far in advance anything then known to the modern world. It w natural and right that school studies should be found on classics, and a classical education was then, and un recent times, the best available. It survived its usefu ness, and the inevitable reaction brought into prom nence a somewhat academic treatment of mathematic and a rather inhuman and too odoriferous scienc Such studies could not give a complete education, ar a tendency to emphasise once more the benefits classics became manifest.

Science, however, has now reached heights and depth far beyond those that could be touched by the Greek and philosophy in the light of science has assimilate the best part of Greek thought and passed on. Histor and archæology trace the rise and fall of five or mor civilisations, in which that known to Herodotus an Livy is but the last before our own, and possess a wealt of records in which a student may learn the deligh of research at first hand. The literature of Europe i the last three hundred years can show masterpieces no unworthy of ancient times, and the Gothic cathedra is as noble a building as the Athenian temple.

It is essential to train modern youth to understan and appreciate modern action and modern thought and a modern humanism is now possible which view classical learning in its right place in a greater whole In that humanism the history of scientific thought fill a worthy place, and, with a more intensive study o some science itself, may give that open mind and spiri of reverent inquiry into truth which is the essence o scientific method, and the best object of a libera education.

Science and Literature.

THE rather widespread feeling that science and literature are, in some way, opposed to one ther seems, at first sight, inexplicable. For we can that science is merely a way of ordering experience terms of certain fundamental principles and con-ts, and that literature is a way of ordering experi-e which employs different principles and concepts. position could arise only if one of these methods fessed to be exhaustive and declared that there was room for the other. But science certainly does make that claim. No scientific man asserts that comprehension of a certain region of experience t is given to us by Shakespeare's plays is contained ny scientific treatise, and although we are frequently d that some poet or philosopher has anticipated some at scientific theory—*e.g.* Einstein's—it is probable t this statement is not intended seriously. Yet it rue that there are many literary men who regard nce as if it were, in some way, opposed to rature.

here seem to be various reasons for this attitude. the first place, it is becoming increasingly obvious t a literary education is only half an education. It still possible for the writing of a poem or the writing a novel to be referred to as "the highest of human ivities," but the statement is not now so generally ieved. An increasing number of people are begin-g to believe that the creation of a great scientific ory may be as great and significant an achievement, high an activity, as the creation of a great work of re literature. From this human, all too human, nt of view we can quite imagine that some literary n find science a sort of rival, and a dangerous rival, literature. But we must admit that this explana-n covers only a small part of a widespread attitude. more important element in the "opposition" to ence is due to the dislike of the materialistic ilosophy with which science was, until recently, pposed to be associated.

That the scientific man is a dull materialist, in-sitive to beauty and incapable of profound emotions, or has been, a commonplace amongst literary ists. A botanist, as is well known, is a man who ows everything about a flower except that it is utiful. That these purblind creatures have an rdinate appetite for facts, and a curious, abnormal leverness," is freely admitted. But since they are nd to everything that makes life to other people rth living, know nothing of the artist's raptures nor the hopes and despairs of passionate natures, lieve that nothing is real except what they can put a test-tube, they must be treated, as Nietzsche says, as mere instruments. They are more costly and exquisite versions of their own galvanometers and spectroscopes. In the great company of prophets, seers, and poets, they have no place. They are merely measuring machines, to be made use of by their betters.

This is Nietzsche's view and it is not uncommon. Is there any justification for this view? It must be admitted that some scientific men almost warrant the caricature. It is a peculiarity of science, as distinguished from the arts, that valuable results can be achieved by mere industry. The possession of a telescope, and of an abnormal capacity for sitting still, have sometimes made their owner immortal. It is true that eminence in science can sometimes be achieved by a man without insight, without imagination, by dint of the unexciting virtue of conscientiousness. Valuable as these men are to science, they have no perceptible existence except in conjunction with a laboratory. To the literary man, for whom greatness is almost synonymous with the capacity for experiencing and expressing profound emotions, the eminent man of science may be a negligible human being—"a mere specialist." It is appropriate that such a being should adopt materialism as a philosophy. He finds nothing in his own soul which seems unlikely to be the outcome of the mutual impacts of little billiard balls, and, being unaware of his narrow limitations, he suggests that this hypothesis will cover everybody's experience. To some of the greatest literary artists of the nineteenth century, scientific materialism, as it was popularly understood, was the final proof of the inadequacy of the scientific mind. It is unfortunate that science is so technical, for it means that non-scientific people cannot distinguish between the great creator and the merely industrious worker, and that only a debased and distorted version of a scientific theory gains currency amongst them.

But while the contempt for and dislike of science manifested by such great artists as Tolstoy and Dostoevsky was largely founded on a misapprehension of what science is, the change which has occurred in the attitude of literary men towards science is certainly connected with the fact that materialism is no longer so vehemently preached by scientific men. Such great scientific theories as the electrical theory of matter and the theory of relativity have finally destroyed, it is felt, that old Victorian mechanical universe, with its "iron laws." The universe has become "enjoyable," in Maxwell's sense of that word when he says that the necessary condition of the enjoyable is that the mind

should believe in the existence of a law and yet have a mystery to move about in. In the new universe of science the poet feels that he has room to exist. Such feelings are not, perhaps, based on reason. It might be difficult to justify them, but even the man in the street feels that the "atmosphere" of the modern scientific universe is very different from that of the universe of, for example, Haeckel. For this reason there has been a change in the literary man's attitude towards science. He is even willing to admit that scientific men of Einstein's rank may, in virtue of their imagination and passion, be ranked with great artists. But although a scientific man may be ranked as an artist, there remains an essential difference between a scientific work and a work of art.

That a scientific treatise may be exceedingly well written nobody will deny. That scientific men may show a delicate and catholic taste in literature, or, indeed, in any art, is also quite true. But it does not follow that a scientific treatise, however well written, can ever rank high as a work of literature. It seems that one criterion of the greatness of a literary work is its "immortality." To achieve this it must deal with subjects of permanent interest, and its presentation of them, although it may not be exhaustive, must be of such a kind that it cannot be superseded. Even where the ostensible subject-matter is of comparatively little interest, the real subject-matter—usually the personality of the author—has this quality. Very few people are interested in the subject of urn-burial, but many are interested in Sir Thomas Browne's unique reflections on that subject. Now it is of the essence of the scientific treatise that it deals with the transitory, for it is of the essence of the scientific conception of truth that science can continually advance; and it happens that a scientific argument is not a favourable medium for the expression of the most generally interesting characteristics of an author's personality. Even the best written of scientific treatises, and written by the best scientific men, such as the Dialogues of Galileo, have no longer the living interest that much older works of literature possess.

The reason is not difficult to discover. This apparent weakness is due to the very strength of science. Science is universally communicable and verifiable, or it is not science. It makes appeal, therefore, to just those faculties and interests that are least individual in men. It is impersonal, as we say. A scientific theory is an interpretation of experience which is valid for all minds precisely because it is not concerned with experiences which are individual. A scientific man has, potentially, all rational creatures for his audience. The artist can make no such claim, but he penetrates to a greater depth. At present the greater part of every man's experience lies outside t scientific picture and, for the majority of men, is far the most interesting part of his experience. T arguments for the belief that the sun goes round t earth, however wittily presented, are of little intere now except to psychological historians. But huma nature has changed much less than scientific theori and a presentation of unrequited love, or of goodne triumphant in adversity, can still be pertinent to pr sent problems and has lost nothing of its illuminati power for being centuries old.

This is not to say, of course, that the deepest hum passions are not concerned with science. Kepler, describing his triumph at his discoveries, wrote so of the finest passages in literature, but those passag describe his emotions, not his discoveries. Th convince us that science may require the highest a deepest emotions for its service, that a great man science may truly be a great artist, that he may gi to science a passion and creative imagination that oth men give to religion. But that does not make problems eternal, or of permanent interest. The fa of a scientific treatise, as Huxley has said, is to be p of the rubble which forms the foundation of the n building.

The distinction between the scientific treatise a the work of literature, therefore, is connected with old question of matter and form. What Shakespe has to convey cannot be otherwise conveyed, bu student may fully master Lagrange's conception dynamics without having read one line of Lagran There is, then, an essential difference between scie and art, and, however far science penetrates i regions of experience it has scarcely yet touched, th will always remain an essential difference. This d not mean that the artist can ignore science. A matter of fact, the scientific outlook affects literature influencing the artist's emotions. Darwin's theory, example, has had a great influence on modern lite ture. The influence of science is indirect; it is important factor in shaping the *Zeitgeist* that prev at any given time, and so influences not only the a but also philosophy and religion. But there can no opposition between science and art except in sense that the artist may feel himself to be in rebell against the spirit of his age, a spirit largely due to scientific outlook current in his time, or more probal that was current a generation or two before his. artist, therefore, does not ignore science; the fact he cannot escape it. When, however, he conce himself merely with the expression of scientific fac theory, and not with the spirit of quest and discov the chords he strikes must fail to find unive response in the human heart.

World List of Scientific Periodicals.

By F. W. Clifford.

It is difficult to conceive a publication which would be of greater value to scientific workers in Great Britain than that which is the subject of this article. Research workers in the realms of science, constantly confronted with references to periodical publications to which they have not immediate access, have often expressed the need for an authoritative list of scientific journals, together with an indication of the British libraries where they can be consulted. In the absence of this information, provincial workers are compelled to spend money and ill-spared time in journeying to and from London for serials which may perhaps be contained in a library nearer at hand.

Such a project has frequently been discussed and been commenced. The Panizzi Club, composed of senior officers of State, Universities, and Professional libraries, got well ahead with a Union list in the early months of 1914, but the War intervened and the work so well commenced by Mr. E. W. Hulme, then Librarian of the Patent Office, came more or less to a standstill. This earlier effort was practically forgotten, when, in 1921, the need for such a list was again urgent, and the Conjoint Board of Scientific Societies appointed a small committee to devise a practical scheme for the compilation and subsequent publication of a World List of Scientific Periodicals.

The Trustees of the British Museum were approached, and recognising the importance of this work to scientific research and bibliography, they consented to allow the compilation to be undertaken by the staff of the Museum. With this very material assistance, and financially fortified by the private guarantees of two well-known men of science, the Conjoint Board felt able to proceed with the proposal. Fortunately, at this critical period, however, the Carnegie United Kingdom Trustees expressed their willingness to add a substantial guarantee if the original scope could be somewhat widened. This action very considerably smoothed the way, and steady progress was made with the List. When the Board itself was dissolved in 1923, the original Committee was formed into a Limited Company so as to ensure the publication of the completed work.

It is intended that the List shall be issued in two parts. The first part is now in the press and will probably be published during the present year. This portion consists of a list of more than 25,000 scientific serials in existence in 1900, or originating between that date and the year 1921, whether still current or not.

Each serial is arranged alphabetically under its title, *e.g.* the Philosophical Transactions of the Royal Society will be found under "P" and not under "Academies, London." The items are numbered consecutively, and these numbers will be used in Part II. to identify the periodical. It will be recognised that in the arrangement of a list of this kind there may be several opinions as to the precise order which should be followed. The fact, however, that Prof. A. W. Pollard, until lately the Keeper of Printed Books in the British Museum, has acted as the editor, should more than guarantee that the final decision has been made in a manner which should meet with the approval of the bibliographer and fulfil the requirements of the scientific worker, whose references to periodicals are so often in a very abbreviated form.

The second part, or Index Section, will indicate in what libraries in the United Kingdom a copy of any of the serials in Part I. can be consulted. Sets of the sheets of the first part are now being circulated amongst important libraries, general and special, both in London and in specified provincial centres, for the addition of this information.

In the provincial centres the aid has been enlisted of certain professors and librarians, who are acting as local secretaries to co-ordinate the information as to periodicals taken in their respective districts. This laborious, but most valuable, work has to be carried out promptly, or otherwise the publication may be delayed. At a later date, perhaps, it may not be out of place to disclose the names of these enthusiasts, to whom scientific workers will always be indebted.

It may be well to mention that the World List is not intended to be a catalogue of the periodicals in any given library. A moment's thought will show the practical impossibility of giving all the libraries containing English journals of considerable circulation. In the case of these, the local secretaries have been asked to exercise discretion as to whether there is any need to indicate the existence of more than one complete set in their town. It would, however, be easy for any centre to use the World List as a catalogue of periodicals in that area by the simple means of stamping with a rubber stamp opposite each periodical possessed by the individual libraries comprising it. Or, as Part I. of the World List is printed on one side only, the entries could be cut and mounted on cards.

The List should also be of service in encouraging co-operation between large libraries in the direction of lessening duplication in their immediate neighbourhood, with the result that funds may be released for the purchase of additional periodicals, and in consequence increase the total number of periodicals contained in that area. At the same time such a survey would

show those responsible, how well, or ill, the research worker is catered for with regard to periodical literature in the respective institutions.

A comparison of the World List of Scientific Periodicals with the "Gesamt Zeitschriften Verzeichnis" shows that the former contains 25,000 whilst the German publication contains but 17,190. The French "Inventaire des périodiques," of which the first number has recently been issued, is not far enough advanced to ascertain the number of periodicals which will eventually be covered by it, but the letter "A" contains 2357 entries as against 2649 in the English production. No conclusion can be drawn from the latter figures, as the arrangement of the entries is not quite the same as that in the World List. Also the information as to libraries refers only to those in Paris itself.

This census of periodicals shows that the scientific journals are steadily increasing in number. Many new serials have commenced life since the War, and n Academies founded from patriotic motives are co mencing to publish printed memoirs. Is it not ti that a halt should be called? Would it not be possi for the older Academies to set an example by encour ing the publication of their own communications in specialised journals? The scientific worker would th have his material more or less collected instead contained in an academic "mixed grill." The searches would reach without delay those most terested, whilst details of abstraction, etc., would very much simplified.

In conclusion, whilst no one library can be expec to contain all the periodicals mentioned in this mo mental work, every library should at least contain copy of the World List in order to direct inquirers the nearest library where a particular periodical m be seen. Scientific research workers will in due ti find that it is indispensable to them.

The Library Association's Subject Index.

SINCE 1915, "The Subject Index to Periodicals"[1] has been issued annually by the Library Association in the form of eight Class-Lists, except for the period 1917–19, when the lists were triennial. The Class-Lists are: A, Theology and Philosophy; B-E, Historical, Political, and Economic Sciences; F, Education and Child Welfare; G, Art and Archæology; H, Music; I, Languages and Literature (Part 1, Classical, Oriental and Primitive; Part 2, Modern and Bibliography); K, Science and Technology; L, Author Index to A-K, and List of Periodicals indexed.

The Index is a classification of articles of reference value selected from an examination of close upon 600 periodicals, English and foreign. The entries are minutely classified under the alphabetical subject headings of the Library of U.S. Congress, and are annotated where it is desirable to define with greater precision the scope of articles. The unbound numbers of periodicals sent for indexing are filed for reference and lending purposes. Any subscriber to the Index can on application obtain the loan of specified articles on payment of the return postage. Further, he can require the editors to furnish him with a list of articles under specified headings in continuation of the last printed Class-List.

Thus subscription to the Index on the part of a small rural or town library raises the status of that library to that of a research institution, for the Index places its readers in touch with the latest developments in thought, policy, and action in all departments of human l while it maintains a library of serials for reference wh is not only larger than the corresponding collecti in the average municipal reference library, but probal also contains serials not to be found in the library the British Museum itself. This work of the Libr Association could not have been carried out with some external assistance. Generous pecuniary assi ance has been forthcoming from the Carnegie Uni Kingdom Trust, while free quarters have been found the editorial staff of the Index and its nucleus l collection in the great National Library of Wales Aberystwyth.

It should be noticed that "The Subject Index Periodicals" was planned at a time when "The Int national Catalogue of Scientific Literature" was s in existence. Hence the Index was to a great ext designed to bridge the gaps which that publication l unfilled. With the discontinuance of "The Int national Catalogue," however, the question of the ordinated publication of indexes to scientific periodi literature once more comes to the front. This subj was brought before the Conference on Bureaux Information and "Special" Libraries held at Hoddesd on September 5-8. It may be taken for granted th international co-operation has failed and that the futu organisation of scientific literature must be effected a national basis.

Secondly, it should be remembered that the State h a well-defined interest in this matter, and should called upon to shoulder its share of responsibility. F example, the principal repositories of the serial lite

[1] Annual subscription, 4*l.* 4*s.* (Agents: Grafton and Co., 51 Great Russell Street, W.C.1.)

re of art, education, science and technology are to be found in the State collections. In the case of many foreign serials, the only accessible copies are filed in these libraries, and naturally their curators possess the requisite qualifications for dealing with the highly specialised class of literature which they control.

Co-ordination in indexing requires the acceptance of a common scheme of classification and headings, and an agreed form of index entry. Further, the financial prospects of success under such a scheme are materially improved if the indexes produced are uniform in format and style and are published by a single agency. These conditions being granted, the actual indexing can be carried out in any home or library.

This method of indexing supplies a sound basis for development and negotiation. Any of the Library Association's Class-Lists could be split into smaller units —and some would no doubt benefit by such division, namely, B-E, historical, political, and economic sciences, and K, science and technology. A suggested inclusion of another 50 or 100 additional periodicals in any Class-List could be met if the State librarian, or secretary of the society in question, were prepared to supply the index entries and supervise or edit the extended Class-List. Any development in this direction would be welcomed by the Library Association.

The Index has now become practically self-supporting. It has been run by voluntary aid—one editor alone being in receipt of a modest salary. Finally, the Association has pledged itself not to treat any profits made by its publication as the property of the Association. Such profits will go either to a reserve fund or, more probably, towards the reduction of the price of its Class-Lists. It is scarcely necessary to add that the accounts of the Index are duly audited by a chartered accountant.

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. Vol. VIII., 1923. Pp. 618. (London: Society of Chemical Industry.) 12*s.* 6*d.* net, post free.

The annual publication of these reports is not an event that evokes widespread interest or comment, yet the reports are always welcome to a goodly number of specialists. They are not original in the strict sense, because they are mainly compilations from the abstracts of original papers that have appeared during the year under review. Nevertheless they are very useful: they save the worker much valuable time; they instruct him concerning advances in branches of applied chemistry of which he has no expert knowledge; and if he believe what his testimonials state, that he has "a good all-round knowledge of chemistry," after reading these reports he will lose his conceit and confess his general ignorance.

The chief difficulty connected with publications of this kind is that the expert is too frequently a bad writer; and the chief defect is the absence of critical insight. It is, of course, no easy task to assess the value of developments that happened yesterday, but more attempts in this direction might usefully be made. Further, the reports would gain in lucidity—and the cost of publication could be materially reduced—if the phraseology were rigorously pruned; redundancy of expression and other forms of "journalese" are too common in the present volume.

A welcome feature in many of the reports is the inclusion of summaries of the trend of events in the economic sphere: a practice which should be extended, especially as there is now no single ephemeral publication which provides, regularly and systematically, information of this kind on all branches of industrial chemistry. The pending publication in the United States of *Chemical Reviews*, which will be issued quarterly and will deal with recent progress, may help to fill the gap which is now apparent in our chemical literature. If the reviews are critical and constructive as well as informative, the specialist may prefer them to annual catalogues of facts; but he will need, and should acquire, both. The comparatively small sale of annual reports of the kind we are used to is a distinct reflection upon English-speaking chemists, and no one will criticise the Society of Chemical Industry for maintaining in adverse times its expenditure on this useful publication, which falls well within the scope of its legitimate activities and of the wishes of its founders and benefactors.

Chemical Encyclopædia: A Digest of Chemistry and Chemical Industry. By C. T. Kingzett. Third edition. Pp. x+606. (London: Baillière, Tindall and Cox, 1924.) 30*s.* net.

Within the last few years several works of this character have been published under various titles. Consequently the fact that the present volume has attained a third edition within a comparatively short time shows that it has supplied a well-defined want, and indicates that a knowledge of chemistry is becoming more and more indispensable to growing sections of our population, such as merchants, brokers, barristers, financiers, manufacturers of all kinds, pharmacists and the like. Chemistry is now so intertwined with almost all walks of life that probably every educated man at some time or other has wished to know something about a substance which he has found necessary for some purpose, and it is to such a class that the present book will appeal. He will here find a brief but clear account in non-technical language of almost every chemical substance that has attained any practical importance, with some of the principal constants inserted. Even professional chemists, who have access to exhaustive treatises on chemistry, will find the book handy for rapid reference, especially as it is clearly printed and attractively bound.

Some omissions are bound to occur in a work of this kind. For example, the well-known names "Westron" and "Westrosol" do not appear, although other preparations with a similar name and composition are mentioned. It would have been advisable to have stated that the basis of these non-inflammable solvents consists of chlorinated hydrocarbons, such as tetrachlorethane, trichlorethylene, and the like.

Studies of Scientific Development.

Isis: The International Review devoted to the History of Science and Civilisation. The official organ of the History of Science Society. Edited by Dr. George Sarton. (Weissenbruch and Co., 49 rue da Poinçon, Brussels.)

A FEW months back the formation of the History of Science Society, to carry on in a more permanent form the work which Dr. Sarton has been doing at the Carnegie Institution of Washington since the War, was announced in NATURE. The first volumes issued under these new auspices have just reached us and encourage the highest hopes as to the future of the enterprise. Estimated on the lowest basis, they are extraordinarily good value for the money, a subscription of five dollars covering the whole. Those who joined for this year will have already received two volumes, counting as Parts I., II., and III. of vol. 3. The first, besides various reviews, contains a longish article by Dr. Sarton himself, explaining under the title of the "New Humanism" the objects of the new association and its organ. It is, in fact, a programme and a confession of faith by the founder. The second is a full and very careful bibliography of all the books and articles which have been approved in the second half of 1923 on the history of science and philosophy and the history of civilisation. Its classification aims specially at bringing out the interdependence of the scientific development of different countries at the same time and thus illustrates the unity of mankind and the unity of knowledge.

The third part, however, is the review proper and contains this time a large number of articles interesting alike to the specialist and the general reader. Four languages are represented among the writers, six being English, three German, one Italian, while French occurs frequently, being the natural language of the editor and forming the bulk of his article on the Irish Walton, the aquiculturist of the middle of the thirteenth century.

Among many good things one may select two other articles for special comment. Both open up a rather unfrequented line of thought in Great Britain. The first is the "bio-bibliography" of Hunáyn Ibn Ighág, the distinguished Arabian medical savant of the ninth century. This is by Dr. Giuseppe Gabrieli, the librarian of the institute in Rome for the study of Mohammedan science; it is intended to be the first of a series of such lives, which are greatly to be welcomed at the present moment when the relations between East and West are in a state of critical tension. The other article which specially attracts us is that by Prof. Lynn Thorndike, the learned author of the recent history of magic a experimental science in the middle ages. He treats *Isis* of the history of science as it appears in the famo French Encyclopédie. He has studied the book ca fully from this point of view and the results are som what unexpected. The encyclopedists are far less fr from medieval prepossessions and errors than th thought themselves, or than posterity has suppose They are far less violent against theology. But th strongest line was the history of industry and t mechanical arts. This was Diderot's own departmer who was himself the son of a cutler. The article on t stocking knitting frame and its 2500 parts is ten tim as long as that on cathedrals! When we remember th this was in 1751, before the steam engine, it would see that we should regard Diderot as even more the proph of the Industrial, than of the French, Revolution.

F. S. M.

Cambridge Readings in the Literature of Science: bei Extracts from the Writings of Men of Science to illu trate the Development of Scientific Thought. Arrang by William Cecil Dampier Whetham, and his daught Margaret Dampier Whetham. Pp. xi + 275 + 8 plate (Cambridge: At the University Press, 1924.) 7s. 6 net.

IN these days many young students are apt to igno or belittle the intellectual and practical achievemen of bygone generations, and any book which deals in a interesting and accurate way with the stages th form landmarks in the development of science is t be commended. In the present work the authors ha shown excellent judgment in their choice of extrac from the literature of science, and the explanato introductions they have written to the extracts ad considerably to the value of the whole.

The book is divided into three sections, of which th first traces the development of men's views on th structure of the universe, beginning with Genesis an ending with Eddington on "Space, Time, and Gravita tion." In the section on the atomic theory are give extracts from Lucretius, Paracelsus, Dalton, Avogadr Mendeléeff, Faraday, Arrhenius, J. J. Thomson, Astor Moseley, and Rutherford, all of which appear to us t be particularly well chosen. The third section, dealin with evolution, contains, *inter alia*, selections from th writings of Aristotle, Lamarck, Lyell, Pasteur, Darwin Mendel, and T. H. Morgan; it concludes with a some what dogmatic passage from Bergson to the effect tha thought, being a product of evolution, will therefor never be able to grasp the true meaning of th evolutionary process. Some readers may demur to th inclusion of Bergson and the exclusion of Kant; other may think that quotations from Genesis, and specula tions of thinkers before the dawn of positive science are rather out of place in an anthology of the literature of *science*; but all will agree that the work as a whol has been excellently done, and that every student o science, whether in school or university, should b encouraged to read it and re-read it.

Social Science.

The Biological Foundations of Society. By Prof. Arthur Dendy. Pp. x+197+17 plates. (London: Constable and Co., Ltd., 1924.) 7*s.* 6*d.* net.

Population and the Social Problem. By J. Swinburne. Pp. 380. (London: G. Allen and Unwin, Ltd., 1924.) 15*s.* net.

THE student of social science may approach his task with either one of two objects in view. He may attempt to expose the permanent conditions upon which social evolution depends. He may, on the other hand, seek to deal with his material in much the same manner as systematists and morphologists have dealt with animals and plants. He may, in short, aim at the building up of a social morphology.

It is seldom denied that the adjective "scientific" is appropriate to studies of the first group. Under that heading falls the study, not of inheritance itself, but of the factors which are operating so as to produce changes in the germinal constitution of the race, and of factors which, given a knowledge of the conditions under which modifications are produced, can be detected in the process of impressing modifications upon each generation. Here also comes in the study of comparative psychology and the study of the manner in which the social heritage is built up, added to, passed on and lost: in other words, of the mechanism of the inheritance of tradition. The term scientific is, on the other hand, sometimes denied to studies which fall under the second heading. It is apparently held at times that they cannot be distinguished from historical studies which, by reason of the fact that they assume the form of a narrative and deal with the particular rather than with the general, are judged not to belong to science.

There are, however, grounds for distinguishing clearly between historical studies and scientific studies of social data. Not only may the latter, as also the former, be made with that detachment of outlook and accuracy in detail which characterises science, but also, in place of aiming at a narrative of particular events, they may aim at what Prof. Hobhouse calls a "descriptive synthesis." This may take the form of comparative social morphology, of the study of the trend of the evolution of an institution such as property, of an association such as the family, or of a particular civilisation. Between such studies, and those undertaken by systematists and morphologists in zoology and botany, it is hard to find any fundamental distinction, though it may be convenient to distinguish between "natural" and other sciences. The rate of progress in this field is slow, and while there may at times be grounds for the complaint raised by sociologists that their studies are not given the recognition which they deserve, it may not be out of place to remark that, if sociologists were to spend less time in discussing the scope of their science, what methods of investigation are appropriate, what the relation of sociology is to other sciences, and cognate questions, if in fact they were to get on with their task, recognition would come more quickly.

When workers in social science have firmly grounded and widely extended their studies, it may be some generations hence, a position may be reached not unlike that which faced Darwin when he surveyed the biological sciences in the middle of the last century. The systematists and morphologists had brought their studies to a point where the main outlines were clear and undisputed. It was then possible to apply to the facts so systematised what was known of the permanent conditions upon which organic life is based and to put forward a theory of evolution. So too in years to come, when enough preparatory work has been done, it may be possible to found a theory of social evolution which will show order and sequence in the data handled.

(1) The need of the time is for scientific research in both these directions. The temptation is to neglect spade work and to elaborate premature theories. It is here that Prof. Dendy's book is helpful. It may be described as a short and elementary course in general biology containing the minimum of biological knowledge that should be in the possession of all students of social science. Those who propose to pursue any branch of social science which falls under the first of the two divisions mentioned above will of course require far more detailed biological knowledge than this book can give. It will be to those whose interests and work lie in the other field that this book will be useful.

It is possible to do valuable work in systematic zoology and botany and to be almost entirely ignorant of general biology. But quite apart from the interest which a knowledge of general biology adds to these studies, such knowledge has a value in that it directs the worker's attention to many facts which he might otherwise neglect as unimportant but which, if recorded, may illuminate general biological problems. So too in studies of social data, some knowledge of general biology is not only interesting but also of great value. Had all those, for example, who have collected facts regarding existing primitive races had some grasp of biological problems, how much might they not have assisted indirectly in solving those problems by amassing data bearing upon them which, in the absence of biological knowledge, seem wholly unimportant? Or again, if attendance at a course in elementary biology was compulsory for those who are going to pursue that branch of social science known as economics, how much more definite and concrete would be their knowledge of the human material with which they deal. Prof.

Dendy's excellent little book deserves a wide audience among students of the various branches of social science.

(2) It is possible to study the population problem by attempting to lay bare the permanent conditions upon which it rests, or by collecting the facts regarding the control, density, or some other aspect of the problem under different conditions and then attempting to ascertain the trend of social development in whatever field is chosen. Mr. Swinburne's book is a disappointment in that, while written by a scientific man, it is not a scientific treatment of this problem in social science. From the book we learn what opinions Mr. Swinburne holds and what prejudices he harbours regarding most social questions of the day, including, for example, the relations between capital and labour, profit-sharing, the rights of man, government, the position of women, trade unions and socialism.

The connexion of all this with population is obscure, but those who disagree with Mr. Swinburne are asserted to hold erroneous views about population, though why they are erroneous, and what Mr. Swinburne's own views may be, are nowhere in the book logically and consistently set out. His reference to economists and their treatment of the population will serve as an example of his tone and style. "The curious point about economists' treatment of the population principle is that they never seriously discuss it or try to refute it." It is only necessary to recall that the fourth volume of the new Cambridge series of economic handbooks is wholly devoted to the population problem, and that a discussion begun by Sir William Beveridge at the Liverpool meeting of the British Association, and continued by Dr. Keynes and other well-known economists, has been occupying a very large amount of attention for more than a year in order to see the value of Mr. Swinburne's statements. All this work is entirely neglected by Mr. Swinburne. Can he have written a book of nearly 400 pages on population in ignorance of it, or, as the following quotations suggest, does he hold so low a view of the intelligence of economists that he does not read their works?

"There is no proper opening for economists, and no adequate inducement for men of first-rate ability to devote themselves to the study. The highest pinnacle an economist can reach is a professorship at some university or college. He may also write a text-book or two and there his career ends. . . . Generally speaking, an able man who can do anything else well has a strong temptation to leave political economy alone. . . . A man who might be a first-rate economist can do nearly as well in many other directions that give more return, and naturally he does so."

Whichever explanation is correct, the conclusion would seem to be that only those who are interested in Mr. Swinburne's prejudices will profit by reading his book.

A. M. C.-S.

India, and its Problems.

India: a Bird's-Eye View. By the Earl of Ronaldshay. Pp. xiii + 322 + 24 plates. (London, Bombay and Sydney: Constable and Co., Ltd., 1924.) 18s. net.

THE Indian Continent is such a vast agglomeration of different languages, different religions, and different peoples, not to mention varieties of climate and topography, that it is no easy matter to present it in a single view without a tendency to confuse and bewilder the reader who is not familiar with the various problems concerned. But Lord Ronaldshay is an experienced administrator who has had opportunities, on the staff of a Viceroy and later as the Governor of a great Indian province, not often enjoyed by those who have an inclination to write, and at the same time possess the pen of a ready writer. Further, he has devoted much time to the study of the history, religions, and archæology of India, in the course of which he has travelled much and has had personal experience of the scenes he describes so well. His position has necessarily brought him into contact with all that is best of modern India both in literary and political circles; so he is peculiarly well equipped to give a general sketch of the country, and in this he has acquitted himself as well as a difficult task permits.

In a chapter on "What the Buildings tell" the reader is introduced to the immense variety of architecture displayed in "the edifices raised over a vast span of time to the known and unknown gods of Indian belief," and the question is asked, Whence came the people who could produce such contrasts?

Thus we are led to the great gateways, on the North West Frontier, in the mountain wall which hedges in and separates India from the rest of Asia, through which successive waves of invaders have passed, penetrating southward and eastward, bringing those Aryan races which have become the most numerous element. But one thing leads to another, so a description of the North-West Frontier, and its people, leads on to the ever-recurring problems connected with this troublesome corner of the Empire, especially those difficulties which have arisen owing to the no man's land existing between the British Administrative Frontier and Afghanistan. The story of our relations with the frontier tribes in recent years is told, and how, in spite of all our desires to the contrary, a forward policy has been forced upon us as the result of the climax brought about by the third Afghan War. We have now had to adopt a policy of permanent occupation in Waziristan, that is, provided the policy remains permanent, an important proviso. It may be ex-

sive, but, probably, less so than the policy of ated punitive expeditions, followed by withdrawal, ch, under present-day conditions, requires an ever- easing number of men to cope with the better ed, and better trained, tribesmen. Permanent cupation will go far to remove the economic causes nrest on the Frontier, which lie at the root of most ur difficulties. We shall also be the better able to otrol those outside influences which have done so ch harm in the past. Lord Ronaldshay's chapters the Indian Frontier problems will do much to ghten those who want to understand what these blems really are.

rom the incursions from Central Asia the author s to the last incursion which reached India by sea m the west. He gives a sketch of the well-known ty of the rivalry among European nations, first for possession of the trade of the East, ultimately for possession of India itself, and the final victory of British. As a typical example of operations in hese early days he describes, in some detail, the battle ofPlassey and a personal visit to the site which he ade a few years ago.

n view of the present-day controversies which surround questions of the form of representative govern- ment best suited to India, all that Lord Ronaldshay has to say on the subject, in the two chapters on "Local Self-Government" and "The Indian Village," is of importance. Because we possess in a high degree the art of managing our municipal affairs by means of elective councils, it does not follow that such methods are suitable to the Indian soil. The author gives numbers of instances of failure of the elective principle. With the advent of the British, Western methods were forced on a people whose ideas of government are radically different from ours. If our methods are to succeed it will only be after a long course of instruction, and, as it were, acclimatisation. But we are not pessimistic as to the future of India, for we believe the British have an innate genius for overcoming these kind of difficulties, and finding a way out, though it may take time. One has a feeling that, on this subject, the author does not express himself as freely as he would like.

Two chapters are devoted to "Industrialism of the West" and "Wealth and Actual Potential." Like Western government, Western industrialism is distaste- ful to Indian ideas, and politicians have not been slow to make use of this fact. In England 80 per cent. of the population is urban, while in India 90 per cent. is rural, engaged in agricultural and pastoral pursuits. As a rule the Indian does not take kindly to factory life in the great industrial centres—his thoughts are in his village, to which he returns at the first opportunity. His heart is not in his occupation, and he often makes an inefficient workman. As a consequence, though wages are lower, a larger number of men are employed to produce a given article than in Europe, which often results in the Indian production being more costly than that which could be imported. The Indian politician, even Mr. Gandhi himself, though inveighing against modern innovations, is not above making use of rail- ways and motor cars. Gandhi has made a dead set against European medicine, "which has been singled out for special attack," but by a curious irony he has recently undergone a serious operation at the hands of a skilful English surgeon who saved his life. One cannot help thinking this antagonistic attitude towards industrialism has more of a political motive than anything else, certainly among the extremists, merely because of its Western origin. In India one often hears the development of Japan applauded as an example of what an Eastern people is capable of achieving.

British future commercial relations with India must be free from the suspicion that we have any desire to exploit her. The author puts this point very well when he says: "It must be for the good of India that her wealth should be increased, and since outside aid is necessary to this end, what has to be done is to make it clear to India that the aid which Great Britain can offer her is given to the mutual advantage of the two countries, that if British business men look to receive a reasonable return themselves, they have no desire to deprive her of a reasonable share of the total profit. In other words, what they desire to do is not to exploit her to her disadvantage, but to co-operate with her in a business of mutual benefit."

Popular Hinduism is dealt with in a chapter de- scribing some of those great religious festivals which play such an important part in Indian life, many of which the author has personally witnessed. When one considers the original meaning, and sublime concep- tions, which have been read into some of these cere- monies, one is astonished at the wide departure from the original one sees to-day. It is not difficult to imagine the sceptic asking whether poets and thinkers in trying to explain away, by dint of allegorical inter- pretation, certain ceremonies, are not making ingenious attempts, though perhaps unconsciously, to put a fair complexion on practices which are not in accordance with modern ideas.

The concluding portions of the book endeavour to explain the reasons for the pessimistic outlook on life which apparently pervades the majority of Indians. This is attributed, partly to climatic and physical surroundings, which have enervated and saturated the people with malaria, and partly to the hopeless

religious doctrine of *Karma*, which lands those who believe in it in a tangled maze. The consequence of this doctrine, to the believer, is that "all existence in this world is suffering and sorrow"; the Hindu's ambition is not to prolong it but to escape from it. In these circumstances how can life be anything but a joyless existence? We are told of the measures which have been, and are being, taken to combat the evil of malaria, a most difficult matter when such a large area is concerned. These are based on the discoveries of Sir Ronald Ross and others, and are being carried out on a large scale, with ultimate benefit to the people.

Lord Ronaldshay always wants to get to the origin of things, and this adds enormously to the interest of what he has to say. Some of his pen pictures are delightful, as where he describes dawn on the Frontier; they vividly recall the scenes with which the Anglo-Indian is familiar.

It has not been possible to do more than touch on some of the topics with which this book deals. We thoroughly recommend it to all who would know about India; it is written in a pleasant style and is the result of much study and experience acquired on the spot. The reader will find something of interest on almost every page. H. L. C.

The Ascent of Man.

Making of Man: a Study in Evolution. By Sir Oliver Lodge. Pp. 185. (London: Hodder and Stoughton, Ltd., 1924.) 3*s.* 6*d.* net.

SIR OLIVER LODGE is unique among our men of science in commanding public attention on general and religious questions, as well as on the branch of science which he has made his own. Hence the little book before us will have a large audience, rather for its qualities of inspiration and feeling than for any definite contribution to its special subject. For on the biological side it is extremely scanty, and compares curiously in this respect with the volume of somewhat similar size and title from Prof. J. Arthur Thomson which we noticed a few months ago. The latter was from the pen of a biologist, this of a physicist, who has adopted with passionate conviction some highly speculative theories on psychical phenomena. But the book shows how perfectly Sir Oliver has learnt to use his great power of clear and simple exposition in the service of the religious propaganda which has now become the main interest of his life. The language is always effective and moving, though the sentiments are often obvious enough, and where he draws on his own province of physics, the illustrations are extraordinarily apt and sometimes beautiful. The conclu ing analogy of the Sun and the Divine is one of the b things of the kind we have ever seen.

But it is only fair to point out to intending read that they must not expect a scientific treatise. For t shortest summary of the biological or sociologi evolution of man, they must look elsewhere, *e.g.* to t little book by Prof. J. Arthur Thomson. Here we ha rather a series of sermonettes, variations on the the that the human spirit is an emanation of the Divi that we may trace in its history clear evidence of upward movement, that this movement is the result continued effort, and that we can only attain a bel in "rational optimism," in the divine governance the world for good, by seeing in this "effort" t necessary condition of any movement. It is here th Sir Oliver's physical analogies are most to the poi He shows in an early chapter how all change in mo ment involves force, and how all force implies resistan This leads to the argument that evil is, philosophica considered, only the reaction implied in action. Thi are not "done easily by nod, even by the Deity."

As the book thus becomes within its limits rathe philosophical, religious treatise than a scientific wo one would like to see some of these philosophical c ceptions more deeply penetrated. But even this se of insufficiency does not prevent a real outburst gratitude and admiration for the veteran thinker a writer, who thus in the evening of his life puts forth su an inspiring exposition of his beliefs on the deep personal questions which move us all; and, though shows his own convictions on psychical phenomena frequent reference to "the other side," he does r allow this prepossession to disturb the general ar ment. Men of all views, in fact, can find something their advantage in the "Making of Man."

F. S. MARVIN.

Prehistoric Times.

Ancient Hunters and their Modern Representatives. Prof. W. J. Sollas. Third edition. Pp. xxxvi+6 (London: Macmillan and Co., Ltd., 1924.) 25*s.* n

IT is nine years since the second edition of Pr Sollas's "Ancient Hunters" appeared. T present book, although substantially the same structure as the last, has been revised and brou up-to-date. New matter has been added involvi the lengthening of the work by more than a hundr pages and the addition of several illustrations. I rapidly developing subject like prehistory it is i possible to say that the last word has been written, b it can safely be prophesied that, in this revised a up-to-date form, "Ancient Hunters" will be for ma

ers to come an essential feature on every specialist's ckshelf, and will remain the best book to recommend o the thoughtful non-specialist reader interested in h subject.

As in the previous editions, the work opens with two apters on quaternary geology and the antiquity of an. There follows a discussion of the thorny eolithic oblem, where Prof. Sollas very judiciously sits on the nce, and next a description of the various Palæolithic ultures (here, perhaps, the specialist will regret the mission of the term Middle Palæolithic for Mous-erian) interdigitated with accounts of what Prof. Sollas considers to be their modern counterparts—the Tasmanians, Australians, Bushmen, and Eskimos. The book concludes with a résumé of our knowledge of the chronology of Palæolithic times.

As regards the chapters on modern primitive peoples, while these are very illuminating to the specialist, perhaps a word of warning may be forgiven for the sake of the casual reader. Similar climatic conditions do undoubt produce a certain similarity of cultures when acting on more or less automatic humanity, but this must not be carried too far. Similar flint implements do not postulate similar ceremonies and modes of life. In the case of the Tasmanians and Australians, it seems positively dangerous to link those cultures in any way with that of early Palæolithic man in Europe, merely on the strength of there being a certain similarity in their stone tools. Although Mousterian culture apparently occurs in quaternary deposits in northern China, linked to that of western Europe by finds in southern Siberia and eastern Europe, it is a far cry from the prehistoric industries of northern China to those of the more or less modern inhabitants of Australasia. The same may be said of the Eskimos, though in this case a similarity in skull form has been adduced. With the Bushmen of South Africa, however, we are on safer ground. Not only are the tools similar but also the art—a much more conclusive criterion—is in some cases almost identical; compare the finds at the Barranco de Valltorta in east Spain with some of the Bushmen paintings—the technique is the same. Again, the Bushmen have a legend that they came from the north, and therefore probably from the same stock which supplied Neoanthropic man to western Europe.

In conclusion, one can have nothing but praise for this excellent third edition, the popularity of the predecessors of which has borne testimony to its worth. Prof. Sollas writes from first-hand information, having taken the trouble to visit personally the sites of discoveries so new that they had to be put in an addendum note at the beginning of the book. It is an open secret, that on receipt of a chance card, he posted without pause to the south of France and waded up to his waist in ice-cold water to see these new finds at Montespan. May this fascinatingly readable book, readable though information or material is never sacrificed to make it so, have the great success it undoubtedly deserves. M. C. B.

The Problem of Atlantis. By Lewis Spence. Pp. xi + 232 + 16 plates. (London: W. Rider and Son, Ltd., 1924.) 10*s.* 6*d.* net.

THE Atlantis problem affects so many departments of scientific inquiry that it is always with us. Mr. Lewis Spence, author of a series of books on the folk-lore of America and Egypt, is an enthusiastic champion of the existence of Atlantis, and of the historic importance of the Atlanteans. In this volume he conveniently collects the classical traditions on the subject and evidence from geology, biological distribution, archæology, and folk-lore, of a former connexion between Central America and the Mediterranean region by a transatlantic land.

There is much geological and biological evidence in favour of the existence of this land in the early and middle Kainozoic—a period, however, long before the age of man; but it gives no direct proof of large islands in the mid-Atlantic at the time required by the Atlantis theory. The direct land connexion between southern Europe and the opposite coasts of America must have been broken at the end of the Miocene; but there may have been surviving islands which have gradually foundered, just as Malta is a fragment of a land that once connected North Africa and Sicily, and has been reduced in size by repeated subsidences. If the rest were submerged, some ingenious critic might claim that the reports of Malta and its Phœnician population and its Knights of St. John were all an allegorical myth; and neither the geologist nor the biologist could refute him.

Atlantis may have been the remnant of a mid-Atlantic land which was inhabited by a cultured race that sent colonies into both the Old World and the New. The author claims that the Cro-Magnon race came from Atlantis and entered Europe from the west—a conclusion which would remove some difficulties. The direct evidence of the survival of Atlantis into the human period depends on the archæological evidence. Mr. Spence shows that the amount in common between Central America and Peru and the Mediterranean region is far more than can be explained by coincidence. He agrees, therefore, with Prof. Elliot Smith that the cultures of Egypt and tropical America were indebted to the same source; but he rejects the view that the connexion was established across the Pacific, owing to the absence of evidence of the Asiatic influences that should have been engrafted on the culture if it had passed from Egypt to America by

an eastward route. Mr. Spence recognises that the people of south-eastern Asia influenced those of tropical America; but he regards this connexion as independent.

The author is indiscriminate in his acceptance of anything that appears to support his views. Many of his arguments are unconvincing, such as the identity of the names Cleito with Coatlicue and of Atlas with Uitzilopochtli. He also accepts newspaper statements, which, though often useful as a clue, are not scientific evidence. Thus he remarks that the discovery in August of last year of a 2¼ mile rise in the floor of the South Atlantic in the course of the previous twenty-five years should make "the scoffer" revise his belief in the stability of the ocean beds; but the author's acceptance of this "mare's nest" may tend to make his readers scoff at a theory which accepts such statements without troubling to confirm them or even awaiting their contradiction.

L'Homme préhistorique dans l'Europe centrale: *Primeval Man in Central Europe*. By Prof. Dr. P. Goessler. Pp. 134 + 40 plates. (Stuttgart: Franckh'sche Verlagshandlung, 1924.) n.p.

In this volume Prof. Goessler, Director of the State Museum of Antiquities in Stuttgart, has published a series of forty plates with descriptive letterpress, each dealing with a type of prehistoric man or of prehistoric culture, the type skull being figured with characteristic associated implements, ornaments, etc. The series begins with Heidelberg man and ends with the races of Central Europe of the present day. Students will appreciate the special attention which is given to the archæology of south-east Germany. The author has not, however, confined himself to Central Europe, and in the palæolithic age in particular the skeletal remains of early man from France and Britain as well as Rhodesian man are duly noted; but Piltdown man obtains no more than an incidental mention in connexion with the Galley Hill skull. In later periods, especially the bronze and iron ages, while the place of origin of German finds is, for the most part, carefully noted, in the case of many of the objects figured from other sources, this information is not given at all or only vaguely. The text is in German, French, and English, but the last-named is so bad as to be unintelligible at times without the original German, and shows almost complete ignorance of English technical nomenclature.

Man before History: *a Short Account of Prehistoric Times*. By Mary E. Boyle. Pp. 128+8 plates. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1924.) 2*s*.

Of the total number of pages in Miss Boyle's little book, one hundred deal with the palæolithic period proper. The remaining 28 pages cover the Azilian, the Neolithic, the lake villages, the arts and crafts of the neolithic age, and the beginning of writing. This may seem a little out of proportion, but as her book is written for young people, her scale of treatment may be regarded as justifiable, especially as in t comparatively restricted space she has been able indicate, at any rate in outline, the more promine characteristics of the culture of the later period. S has wisely paid particular attention to the art of p historic man. Indeed, there is no book of this si and type which contains so many excellent reprodu tions of the cave paintings and the carvings as ha been given by Miss Boyle. The later and less we known art of Spain also receives due attention. M Boyle tells her story in a straightforward mann which is very much to the point. Within its lim this is an admirable little book and one of the be of its kind.

The Evolution of Man: Essays. By Dr. G. Elli Smith. Pp. viii+159. (London: Oxford Unive sity Press, 1924.) 8*s*. 6*d*. net.

In this volume Prof. Elliot Smith has reprinted thr addresses—his presidential address to Section H at t Dundee meeting of the British Association in 1912, paper presented to the British Academy in 1916, and lecture delivered at the Royal Institution in the curre year. Each deals with some one aspect of ma evolution, with particular reference to the specifica human attributes which evolve *pari passu* with t development of the brain. To them he has added foreword in which he demonstrates with diagrams tentative scheme of the relationships of the differe genera, species, and races of the human family and similar scheme of the relationship of the order of p mates. In the former of these he puts forward wh are undoubtedly very suggestive views on the proble presented by Eoanthropus and Rhodesian man. Pr Elliot Smith has republished these lectures to meet t need for a consistent and coherent account of t essential factors in the evolution of man, pending t preparation of a more elaborate text-book, which, it needless to say, will be heartily welcomed by all who a interested in this subject.

Origins in Place Names. By An Ignorant Stude VI.: *Life*. Pp. 7. (London: Privately printed the Chiswick Press, 1924.) n.p.

Although numbered the sixth in the series, this is t fourth in order of publication of the pamphlets which "An Ignorant Student" discusses the origin place-names from various aspects. In this case l object is to link up place-names with the order universal law by showing that they evolve logical from a conception of life as functional and the resu of an arrangement and grouping of individual uni Just as from the leaf of a tree certain deductions can drawn, it is possible to deduce from language, which an expression of life, the country in which it grew and, careful analysis, to arrive at the elements of which it composed. The author's conclusion, therefore, is th among the earliest forms of language were the word which we now call place-names, describing and locati the homes of the people who used them. This, somewhat obvious, is no doubt true, provided a reserv tion is made in favour of the priority of certain oth classes of words dealing with the personality a primary needs, such as food.

The Galapagos Archipelago.

lapagos: World's End. By William Beebe. (Published under the auspices of the New York Zoological Society.) Pp. xxi+443+65 plates (9 coloured). New York and London: G. P. Putnam's Sons, 1924.) 42*s.* net.

THE Galapagos Islands are situated directly on the equator, about 500 miles distant from Ecuador, which claims their sovereignty. They are volcanic islands, arising precipitously from a bank at 2000 metres, and their topographical connexion is with Costa Rica and Panama, 650 miles distant, with the lonely Cocos island between. They number 13 larger islands with numerous coastal islets, the largest island (Albemarle) more than 70 miles long, and they were formerly described as having 2000 craters. They are all volcanic, and every few years there are outbursts in one or other of them. Unfortunately they have no water, except what accumulates in pools in a short rainy season, so that the vegetation is relatively scant, except in selected spots, without that accumulation of broken-down rock and plant remains, which forms the rich soil of most tropical islands. Their shores are rocky in the extreme with cliffs and great boulders, and small inlets here and there, the sort of shore one is accustomed to expect on oceanic islands formed by submarine volcanic activity after the ash is washed away and the lava laid bare. Their surface is jagged rock with bushes and cacti in the crevices, so inexpressibly uncomfortable and thirsty that the interior of the larger islands would seem never to have been explored.

"A land pitted by countless craters and heaped into a myriad mounds of fragmentary rock; gnarled trees bleached by salt spray, with twisted, stunted branches; grotesque cactus stiffly outlined against black lava boulders . . ."

First the scene of the legendary adventure of an Inca king, then in 1535 explored for spices and gold by a Spanish bishop, later for almost 200 years the refitting station of buccaneers and whalers in succession, the Galapagos may now be described as almost a holiday resort for scientific expeditions. Chatham island alone was inhabited as a penal and cattle station, the others almost untouched save for the ravages of pigs, goats, cattle, donkeys, and dogs on different islands. Dampier, that great exploring buccaneer, Porter, a raider on peaceful whalers, Darwin, a young ship's surgeon of twenty-six, and others, described them in terms which are generally correct to-day, so small are the changes produced by man.

The Californian Academy of Sciences, in an expedition under R. H. Beck in 1905, collected for almost a year and secured specimens of all sorts in such vast numbers that further collecting would seem unnecessary. However, in 1923 the New York Zoological Society adventured through one of its patrons, Harrison Williams, who took a party on board his yacht for a three weeks' cruise there. Beebe, one of the soundest of the United States naturalists and a most enthusiastic observer, was in charge, having W. M. Wheeler as entomologist and a party of twelve more including curators, artist, photographers, historian, preparateur, physician, and taxidermist. The object was clearly to get living animals for the Society, exhibition specimens for the Museum of Natural History at New York, and films and photographs of wild beasts, that still have no fear of man, for the general public. It was simply a scientific reconnaissance, extraordinary only in the quality and completeness of its personnel and equipment, and in these respects it may be described as "the last word." The immediate result is a readable book by Beebe, full of interesting observations, while Osborn contributes as florid an introduction, "In the Wake of Darwin," as we ever remember to have seen outside journalese, describing the expedition as "among the scientific wonders of our century"; "It is like rubbing the Aladdin's lamp of science," etc., terms which we would ourselves prefer to apply rather to the wonderful series of American palæontological results to which that author has himself been such an inspiring contributor.

Space permits reference to only a few of the natural history observations. We particularly like the accounts of the sea iguanas, up to 4 feet in length, in their vast numbers on suitable rocks, swimming by their flattened tails with hanging-down legs by which they cling for browsing on the seaweeds in the foam of the breaking waves and by which they drag themselves on land; the description of a crab crawling over one and picking off its ticks would not be believed if described by any other observer than Beebe. The mocking birds (Nesomimus), their habits and distribution, are scientifically interesting, once continental visitors, now perhaps species in the making in the different islets. A small penguin occurs, the only example north of the equator, and then there is the flightless cormorant, a bird one third longer with its wings 40 per cent. shorter than its nearest allies, as wonderful in many ways as the classic great auk, and like it, assuredly, doomed to disappear.

The huge southern sea-lions were generally so tame that the naturalists could approach and pick up their babies at will, their chief foes and those of the seals being rather of the water than of the land. Buccaneers and whalers came to the islands largely for the giant land tortoises, and the Californian Academy Expedition collected more than 250 specimens in which they recognised 15 species, separated from one another chiefly

on shape, with no real structural differences. They are known from 11 islands, each of which had one race, with the exception of Albemarle, which had several. All the evidence points to no interchange of tortoises between the islands, and the problem here, as in the Mascarene islands, is the method of their arrival, the evidence of any continuous land mass for their transport being equally small. Beebe only took one, and that from the bottom of a crater on Duncan Island; he found that it swam well and intelligently, this being against his views as to the necessity of a former land connexion with Costa Rica to explain the flora and fauna now existing in the Galapagos. At Albemarle they used to occur on the highest mountains, where there is much rank grass. A Guayaquil farmer started here a ranch to round up the cattle for their hides while the old tortoises were killed for their oil, few young, if any, surviving the depredations of the dogs. Whether any still exist in Albemarle is doubtful, and anyhow, unless there is some reservation, they will soon be known only as beasts of a past age. This is the fate which has befallen the land iguana on most islands, but Beebe found them still numerous in South Seymour. These lizards attained a length of 50 inches and live inland in holes which they scratch in the ground. They are vegetable feeders, their epicures selecting buttercup flowers and their gluttons cactus fruits and leaves with their spines and all, the former shaken down like apples from a tree. In fighting, unlike most large lizards, they use their jaws rather than lateral swishing movements of their bodies.

There is much else in Beebe's book to which we would like to refer: the finding of six bleached skeletons of the rare killer whale (Pseudorca), the capture of a species of Branchipus, many notes on the habits of birds, insects, and crabs, and a whole chapter on the life in rock pools. The impression we have gained is that, while there is no use for any more exploring expeditions, the Galapagos is still an immense field for the naturalist in the study of the mode of life and of the life histories of all the more lowly land forms. In particular, from a species point of view, the insects scarcely seem to have been touched, and a collector of the type of Perkins or Scott might find as rich a fauna as these two found respectively in Hawaii and Seychelles. We suggest to the New York Zoological Society that all speculation as to the origin of the Galapagos fauna is vain in the absence of such an intensive study, and that the outcome of their reconnaissance should be a determined attack directed to this end, before the islands are altered still more by the animals man has introduced. This, we conceive, is what the progress of biological science demands from them.

J. Stanley Gardiner.

Animate Nature.

Animal Studies. By James A. Todd. (Foundati of Nature Study Series.) Pp. 135. (Edinburg A. Baxendine and Sons, 1924.) 2*s.* 6*d.* net.

With the best intentions in the world it is impossi to give an adequate summary of the animal kingd in ninety small pages of print, and the author of t little book has attempted too much in the spa allowed him. The book has been published mainly obviate the so-called waste of time involved in no taking by students. The author's own lectures m of necessity have been fuller than the very imperf summary given here would indicate, and judicic notes taken by the students themselves at the ti would have been infinitely more useful to them. T book is an example of that tendency to excessi spoonfeeding which is so much to be deprecated modern educational methods, and can serve no rea useful purpose. The illustrations are poor and in ma cases unrecognisable. We have not detected ma actual errors of fact, but Asellus is not found on t seashore, and the generic name of the blow-fly is correctly given.

Vivarium and Aquarium Keeping for Amateurs: Practical Guide to the Hobby. By A. E. Hodge. P 128+6 plates. (London: H. F. and G. Witherb 1924.) 5*s.* net.

As the author justly remarks, the construction vivaria and aquaria is mainly a matter of comm sense and ingenuity, based on an adequate knowled of the habits of the animals to be kept in the Mr. Hodge is, therefore, content to lay down a f guiding principles and to devote the main part of t book to those special requirements of food and enviro ment peculiar to individual species, the knowledge which is only gained by experience. In this respe the book is most valuable, and the author's hints a practical advice will save the beginner many an anxio hour and many an unnecessary loss. Attention confined to reptiles, batrachians, and fishes, with speci reference to the British species, and only to those whi require no heating apparatus. The book makes timely appearance in view of the opening of the ne aquarium at the London Zoo, and should do much popularise a fascinating hobby.

Deer-stalking in Scotland. By Alexander Inks McConnochie. Pp. 208+8 plates. (London: H. and G. Witherby, 1924.) 10*s.* 6*d.* net.

The author has here collected together a series memories and adventures among the deer forests Scotland, contributed by enthusiastic devotees of t sport of deer-stalking, and a goodly number of stalki yarns wherewith to beguile the autumn evenings aft a good day on the moors. The book is essential written for the sportsman rather than the naturalis The chronicle is well and racily told, and will appeal all those who have experienced the thrill of the hun The Duke of Atholl contributes a preface, in which h touches briefly on the much-disputed question of th economics of deer forests.

Thermionic Valves and Radio Communication.

Thermionic Valve and its Developments in Radio-telegraphy and Telephony. By Prof. J. A. Fleming. Second edition, fully revised. Pp. xiii + 438. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1924.) 15*s.*

So rapid have been the advances made in radiotelegraphy and radiotelephony that the author has found it necessary to rewrite much of the first edition of this useful book. The invention of the two-electrode thermionic valve by Prof. Fleming in 1904 made an entirely new departure in the radio art. The subsequent development of the hard three-electrode valve marks an equally important advance. With the exception of the crystal detector, all other types of detector for electric waves have now been made antiquated. As a generator of electric oscillations the valve has come to the front. As a relay or repeater in telephony also it is being very widely used. The author has added a new chapter on thermionic relays. A telephone line filter is described, and a clear account is given of carrier wave telephony applied to ordinary telephone lines. Speech has been transmitted perfectly from the Atlantic to the Pacific Ocean. It first passed by radio thirty miles over the sea, then 4000 miles overland by wire, and finally it passed thirty miles over sea again by radio. All the transmissions were effected by thermionic valves, no human agency being employed.

Thermionic Tubes in Radio Telegraphy and Telephony. By John Scott-Taggart. Second edition. Pp. xxiv + 470. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1924.) 15*s.*

The thermionic valve has come into almost universal use for radio-communication. This volume describes the development of this valve and gives many of its applications. The author has considerable practical experience of valves and has made a judicious selection from the leading papers and the more important patents on the subject. If he errs at all, it is in making the book too comprehensive and going too much into detail. A beginner reading this book almost wants some one to point out what to read and what to omit, at least, on a first reading. Very properly the author begins by describing the phenomena in terms of modern theory. But we are afraid that our imagination fails to grasp what is meant by saying that there are about 10^{22} free electrons in a cubic centimetre of cold metal. Current is taken as flowing from points of high negative potential to points of low negative potential. Modern theory certainly explains very satisfactorily the working of the three-electrode thermionic valve. We can recommend this book to serious students of the subject.

Wireless Possibilities. By Prof. A. M. Low. Pp. 77. (London: Kegan Paul and Co., Ltd., 1924.) 2*s.* 6*d.* net.

It is useful occasionally to try to unravel the future. This is usually left to poets. The author of this little book, however, encouraged doubtless by the marvellous linking up of the whole world by radio-communication, has ventured to indicate some of the lines along which future developments will probably take place. Incidentally the reader learns many useful scientific facts. Radio television has almost been realised. Why not methods of preventing local thunderstorms and of improving the growth of wheat or of young animals? Radio waves may affect our health. Why should we not try to render this effect beneficial? The days of the outside aerial are limited. The study of radio-active materials may in one day produce the cold-emitter valve. It is difficult to believe that we are not on the eve of great scientific developments.

Forthcoming Books of Science.

Agriculture, Forestry, and Horticulture.

Ernest Benn, Ltd.—Varieties of Cultivated Oats, H. Hunter; Agricultural Progress: The Year Book of the Agricultural Education Association, 1925; "The Fruit Grower" Directory and Handbook, 1925; Cut Flowers for Market, F. J. Fletcher. *A. and C. Black, Ltd.*—Gardens of South Africa, Dorothea Fairbridge, with 16 page illustrations in colour from pictures by Elizabeth Drake and others. *Cambridge University Press.*—Farm Accounts, H. S. Orwin, new edition. *Central News Agency, Ltd. (Johannesburg).*—Cotton in South Africa, W. H. Scherffius and J. du P. Oosthuizen (S.A. Agricultural Series, Vol. III.). *Chapman and Hall, Ltd.*—Principles of Dairying, Judkins. *Hutchinson and Co.*—The Culture of Bulbs, Bulbous Plants, and Tubers Made Plain, Sir J. L. Cotter, Bart. *Longmans and Co.*—My Garden Book, J. Weathers; Every-day Life on an Old Highland Farm, 1769–1782, I. F. Grant, with a Preface by Prof. W. R. Scott. *G. Routledge and Sons, Ltd.*—Practical Forestry, from a Workman's Point of View, A. C. Drummie.

Anthropology and Archæology.

D. Appleton and Co.—Human Origins: A Manual of Prehistory, Dr. G. G. MacCurdy, 2 vols. *Cambridge University Press.*—The Races of Man and their Distribution, Dr. A. C. Haddon; The Social and Political Systems of Central Polynesia, R. W. Williamson, 3 vols.; The Origin of the English Nation, Prof. H. M. Chadwick, reprint; The Medieval Village, G. G. Coulton. *John Lane, the Bodley Head, Ltd.*—Our Prehistoric Forerunners, C. E. Vulliamy. *Longmans and Co.*—Great Peoples of the Ancient World, Dorothy M. Vaughan. *Macmillan and Co., Ltd.*—The Belief in Immortality and the Worship of the Dead, Sir J. G. Frazer, Vol. III.: The Belief among the Micronesians; Ritual and Belief in Morocco, Dr. E. Westermarck, 2 vols.; Leaves from "The Golden Bough," culled by Lady Frazer; Men and Thought in Ancient India, Prof. Radhakumud Mookerji. *Methuen and Co., Ltd.*—Primitive Law, E. S. Hartland; Primitive Labour, L. H. Dudley Buxton; Folk-lore Studies: Ancient and Modern, Prof. W. Halliday. *G. Routledge and Sons, Ltd.*—Social Organisation, Dr. W. H. R. Rivers, edited by W. J. Perry; The Earth before History, E. Perrier; Prehistoric Man, J. de Morgan; A Thousand Years of the Tartars, Prof. E. H. Parker; The Threshold of the Pacific, Dr. C. E. Fox, edited by Prof. G. Elliot Smith; London Life in the XVIIIth Century, M. Dorothy George; Language: a Linguistic Introduction to History, Prof. J. Vendryes; A Geographical Introduction to History, Prof. L. Febvre. (History of Civilisation.) *Seeley, Service and Co., Ltd.*—Arabs in Tent and Town, A. Goodrich-Freer (Mrs. H. H. Spoer); In the Nicobar Islands, G. Whitehead, with a Preface by Sir R. C. Temple, Bart.; Pygmies and Bushmen of the Kalahari, S. S. Dornan.

Biology.

D. Appleton and Co.—Evolution, V. Kellogg; Race Hygiene and Heredity, Dr. H. W. Siemens, translated by Dr. L. F. Barker; The Criminal as a Human Being, G. S. Dougherty; Fishes, Dr. D. S. Jordan, new edition.

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NATURE

SATURDAY, SEPTEMBER 20, 1924.

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2864, VOL. 114]

Coal and Electric Power.

A STRONG plea for an improved utilisation of coal as a source of motive power is made in the second part of the volume "Coal and Power,"[1] the Report of an Enquiry presided over by the Rt. Hon. D. Lloyd George, the first part of which has been referred to already in these columns (August 23, p. 265). The Committee of Liberal Members of Parliament and other persons responsible for the Report has examined the present system of generation and distribution of electrical power in Great Britain, and has come to the conclusion that "immense saving and improvement can be effected in this respect."

The waste that occurs in the methods now in vogue in connexion with the utilisation of coal for industrial and other purposes is a subject which has been under close study on the part of engineers in Great Britain, as well as in other parts of the world, for several decades past; the measures by which this waste can to some extent be reduced have been repeatedly indicated by them. The subjects of coal conservation, home-grown food, and the better utilisation of our labour were, for example, chosen for the theme of the able and brilliant presidential address which Mr. S. Z. de Ferranti delivered on November 10, 1910, to the Institution of Electrical Engineers (see Jour. I.E.E., 1911, vol. 46). In this address, Mr. de Ferranti directed attention to many of the matters which are dealt with, under the title "Power," in the Report before us, and pointed clearly to the direction in which a reduction in the cost of production of electrical energy should be sought, indicating, at the same time, that the increased use of electricity was a matter that depended almost entirely on the cheapness at which it could be sold. In view of the slow progress which has been made in Great Britain in extending the use of electricity for industrial and domestic purposes, and for the reason that important benefits would follow on its extended use, it is all to the good that the Committee should, in its Report, have again directed attention to the advantages to be gained from the electrification of our industries and our homes.

The Committee points out that the reorganisation of the coal-mining industry which it is advocating, though a matter of the utmost importance, is only part of a programme which aims at the rejuvenation of British industry, and it frankly admits that it is seeking the solution to the problem of how to increase wages without at the same time increasing the cost of manufactured commodities. The Committee shows that there is nothing incompatible in aiming at attaining

[1] Pp. xiv + 139 + 16 plates. (London: Hodder and Stoughton, Ltd., 1924.) 1s. net.

both these ends simultaneously. "A survey of the chief industrial countries of the world reveals," says the Report, "the extremely significant fact that those people are best paid and most prosperous that make most use of the resources of science"; the reason for this state of things being found in the fact that the average level of earnings must depend on production, and production increases as the use of power per head of the population increases.

Attention is directed in the Report to the circumstance that Great Britain became, in the first half of the nineteenth century, pre-eminent in the world as the greatest of all manufacturing countries because it was the first country in the world to realise the potential powers of steam. British engineers led all other countries; and, in the matter of railways, our system was the pioneer one. In the early days of steam engineering it was Great Britain that other countries copied: but now, in the matter of electrical development, the rôles are reversed. The Committee alludes to the activities of other countries which are our competitors in the world's markets, and mentions the fact that most of them are pressing ahead with schemes of electrification. "When one surveys the modern industrial world from this angle, it almost seems," says the Report, "as though we alone are content to mark time." An authoritative estimate indicates that the increase in the production of electricity in Great Britain during the period 1913 to 1922 was 130 per cent., an increase which is less than that achieved in any of the countries of our chief competitors. Again, whilst the development in Great Britain has hitherto been almost entirely in the direction of adding units to existing small and scattered local supply stations operating independently each of the others, foreign countries have in recent times been concentrating on larger power supplies on modern methods linked up and co-ordinated by main transmission lines.

A brief examination is made in the Report of the electrical development in certain foreign countries. This examination discloses the fact that the United States of America leads the way, its output having quadrupled since 1912; Chicago alone produces five times as much electricity as the whole of the North-East Coast plant, the largest scheme of electrification in England. The output in France had, up to April 1924, increased more than three and a half times as compared with 1913; the network of transmission lines is now so widespread that the ordinary hydro-electric stations are linked up with the glacier stations, and both with the thermic stations, and all with the consumers in the industrial region. It is expected that, by 1927, sixty-nine per cent. of the population will have electricity available. Germany, though harassed by many adverse factors, has made a greater adva in the direction of electrical development along c saving lines than has Great Britain; its output more than doubled since 1913. Lignite, a mineral very poor qualities, is now supplying nearly one-h of the electrical power of Germany.

In Holland, production more than doubled betw 1913 and 1918. A scheme is now in hand which ai at covering the country with a network of high-tens transmission lines with the view of supplying Du industries with cheap power; on its completion, t output of the country will be increased 76-fold. In t case of Italy, special State encouragement is being gi to the development of hydro-electric generation; the year November 1922-November 1923 no fewer th 134 concessions for water-power schemes were gran by the Government. A great scheme intended for t development of the resources of Calabria was begun 1923. In Czecho-Slovakia an Electricity Act w passed in 1919 providing for financial aid from t State for electrical development. Great activity the development of hydro-electric schemes has prevail in Canada in recent years. Although the populati of the Dominion is only about one-sixth that of t United Kingdom, Canada will by the end of 1924 getting from hydro-electric plant alone more pow than the engine capacity for the whole of the iron, ste engineering, shipbuilding, and textile trades in Gre Britain. As regards the supply of cheap elect power through hydro-electric plants, Great Brita cannot compare favourably with some other countri It is, however, becoming more evident every year th water-power is not an indispensable adjunct to ma electro-chemical and electro-thermal enterprises, a that other sources of power sometimes possess decid advantages.

The reason for Britain's comparative failure in t field of electrical development is traceable, the Repo rightly points out, to the state of our legislation, t effect of which has been gravely to handicap the geni of our engineers; "the power companies establish under the Power Acts have never been given an adequa chance to develop. They have suffered from the fa that already there had been established in all industri centres and in all our great cities, local and municip power supply undertakings which were organised on purely local basis." This circumstance precluded fr competition between the power companies and t existing authorities. The measures taken to remed this unfortunate situation are mentioned. As a fir step, a Coal Conservation Committee was establishe in 1917; it made a Report of the utmost importanc (Cmd. 9084). The matter was afterwards considere by another Committee, under the chairmanship

A. Williamson, which made certain specific re-mendations.

he Government of the day then took action and sed the Electricity (Supply) Act, 1919 (9 and 10 V. c. 100), in which was incorporated many of recommendations alluded to, and under its pro-ions have been brought into existence the Electricity ommissioners; in this body has been vested the general ctrol over the generation and distribution of electricity the United Kingdom. The Government did not ure in the Act of 1919 all the powers in relation to tricity supply it was seeking; the Bill was strongly posed in the House of Lords. Later, the Government ght and obtained further powers under the Elec-ity (Supply) Act, 1922 (12 and 13 Geo. V. c. 46), ich, though it improved matters to some extent, did effect, and was not designed to effect, the original ention, namely, that of replacing many small stations a few great power stations, with resultant economies coal and in money.

Dealing with the place of electricity in modern life, essential requirement, it is pointed out, is cheap wer; so far, this result has not been secured in Great itain on any notable scale. As an illustration, the e of Lancashire is quoted; this county is, from the hnical point of view, the most favourable area in gland for the generation and distribution of electricity eaply, yet, at the date the Coal Conservation Com-ttee of 1917 made its Report, the cost per unit was Lancashire nearly three times that paid in the North-st Coast district of England. Examples of a similar parity in the cost of energy are to be found in other rts of the country, and are due to the same cause; hereas in Lancashire a number of corporations are pplying energy in circumscribed areas, in the North-st Coast district a super-power station is trans-itting energy in an area of suitable dimensions rough well-placed main transmission lines. The ed for the elimination of waste, the importance of curing an increase in the use of electrical power and e financial and other advantages likely to accrue to e community from the removal of the smoke evil, e saving of by-products and a revival of rural dustries, are all duly emphasised in the Report.

The Committee makes allusion to the very conserva-ve policy which has been pursued by British railway mpanies in the matter of the electrification of their stems, and expresses the hope that in view of the ct that the financial and technical advantages of ectric over other forms of traction are being clearly emonstrated in foreign countries, our railway directors ill reconsider their policy in this matter, and further, at in the event of a national scheme of electric supply eing undertaken, the railways will give it the advantage of their co-operation. "Railway electrification would do much," says the Report, "to assure the economic and technical success of electrical production on a national scale"; in this view many eminent engineers concur. The Committee also points out that there are many recent processes, *i.e.* (1) the fixation of atmospheric nitrogen, (2) electric smelting, (3) the recovery of dyes, which are only possible economically in a country well equipped not only with electrical plant, but with *modern* electrical plant.

The unemployment problem also receives attention in the Report. The Committee attributes the failure in Great Britain to utilise the great unemployed labour force which has been available for construction purposes since the War partly to the limitation of the powers of the Electricity Commissioners. "We believe that it would have paid the State," says the Report, "to have expended large sums in the development of our resources by the provision of State credits, or the loan of public money at low rates of interest, for by so doing the internal economy of the country would have been improved and non-productive expenditure reduced."

In view of the present situation, the Committee is impressed with the necessity that exists for steps to be taken immediately to remedy the backwardness of Great Britain in electrical development. It recognises that the Electricity Commissioners have since their creation rendered most valuable services, but feels that this body is seriously handicapped owing to the insufficiency of its powers, and to some extent by the vested interests of the local undertakings, which, in the nature of things, are not and cannot be "as efficient as a national system developed in accordance with the most recent practice and supplying electricity in bulk from super-power stations." For these reasons, the Committee recommends that the powers of the Electricity Commissioners should be enlarged; this body could thus be placed in a position effectively to remove the obstacles which now block the way to electrical development in Great Britain.

It is mainly in two directions that the development of our great power-producing organisations is now being hindered: (1) by the existence of a number of small and inefficient local supply bodies; and (2) by reason of the magnitude of the undertaking and the uncertainty of financial success under existing conditions. To overcome the first of these difficulties, the Committee would like to see the Electricity Commissioners endowed with compulsory powers of acquisition, co-ordination, and regulation. To overcome the second of these difficulties, the Commissioners should, it is suggested, be granted full powers to employ every practicable means for encouraging and helping

electrical undertakers, public and private, who are prepared to establish generating stations of suitable capacity and type. Finally, the Report lays particular stress on the need for the Commissioners being authorised to empower electricity undertakers "to acquire compulsorily and at reasonable prices all land, rights of way, rights relating to water, and all ancillary rights, which may be necessary for the adequate execution of a national scheme."

The additional powers which it is recommended should be conferred on the Electricity Commissioners are undoubtedly large; however, few persons, if any, who are familiar with the electricity requirements of Great Britain are likely to cavil at the proposals made by the Committee. The situation which has to be dealt with is a very complicated one, and the reforms indicated, which undoubtedly are all urgently required, can only be brought about expeditiously by vesting in the Commissioners exceptional powers.

An idea as to how complicated the present situation is may be gathered from a perusal of the recitals of the "Order made by the Electricity Commissioners under Sec. 7 of the Electricity (Supply) Act, 1919, constituting the London and Home Counties Electricity District and establishing and incorporating the London and Home Counties Joint Electricity Authority" (H.M.S.O.). This Order was made on July 17 last after an investigation of many days' duration, and has been submitted to the Minister of Transport for confirmation; the interests and rights of the London County Council, the City Corporation, and 14 Power companies are involved, and it has been necessary to promote two Bills in the present session of Parliament in connexion with the Order. Situations which are equally, if not more, complicated exist in those parts of the country which have yet to be dealt with by the Commissioners.

It may well be asked, Why is it that the United States of America lead in the matter of electrical development? The answer to this question is to be found in the presidential address which Mr. W. H. Patchell delivered on March 21, 1924, to the Institution of Mechanical Engineers: this exceptional development, he tells us, is the direct outcome of the skill and zeal of those who handle the sales department of the American electricity supply undertakings. It will be evident, then, that if results similar to those obtaining in the United States of America are to be achieved in Great Britain, not only must additional powers be given to the Electricity Commissioners, but those responsible for the conduct of our electrical undertakings must also take a broad view of the commercial side of the business and adopt active measures for pushing the sale of their commodities.

Nature and Man in Tropical Africa.

Big Game and Pygmies: Experiences of a Naturalist in Central African Forests in Quest of the Okapi. By Cuthbert Christy. Pp. xxxi+325+56 pl (London: Macmillan and Co., Ltd., 1924.) 21s.

DR. CHRISTY'S "Big Game and Pygmies," ba as it is upon almost twenty-five years' c tinuous experience of tropical Africa, is a most inter ing and valuable book. The "external aspects organic nature" are not merely being modified human interference in Africa; they are there b rapidly and almost completely transformed. value of the observations so faithfully recorded in volume will therefore steadily increase. When at the varied face of Africa shall have been reduced dead level of cultivated monotony; when all its no animals and plants shall have been replaced by peac beasts of the farm and dull vegetation of econo importance, this will be one of the books that enable our heirs to appreciate what sacrifices we m in the names of civilisation and commerce.

An admirable account of the great equatorial r forest is given by Dr. Christy. Stating that it m once have stretched as an unbroken belt comple across the continent, he describes its destruction at hands of men. A good deal of the forest was destro before the advent of the whites; and to-day too, barbarous methods of agriculture employed by natives are responsible for a great deal. Strip a strip is cleared, by felling and by fire, along the fo margins. Ignorant of the art of maintaining fertility, the natives soon exhaust the virgin richn of the forest soil and proceed to make further depre tions upon the forest. The abandoned clearings quickly overgrown by grass and bush; but upon t sun-baked and exhausted soil rain-forest never appears. The forest once destroyed thus goes for ev and with it must disappear many of its inhabita Not improbably much of that progressive desiccat of Africa, about which so much has been written fr the days of Livingstone onwards, is to be regarded a direct consequence of the destruction of the equato forest. That is a matter worthy of consideration, a it is possible that the conservation of the remnants this great forest will loom as largely in African poli in a few years' time as reparations, for example, h done in those of Europe recently.

While native activity slowly but surely results in replacement of one African type of life by anoth white enterprise appears to be leading to the extir tion of the African biota. Enormous tracts of coun are being cleared of the indigenous vegetation a replanted by exotic plants of economic importan

For example, Dr. Christy foretells the time when South American Ceara rubber will replace the "profitless" bush and marginal forest and supply the world with gutta-rubber serviceable for all ordinary purposes at a penny a pound. From the selfish point of view of the dweller in remote temperate countries, that, no doubt, is good news; but from the point of view of a naturalist it is a deplorable prospect. A proportion of the native vegetable and animal inhabitants of Africa will doubtless succeed in adjusting themselves to the new conditions, but for a very large number, and among them the most interesting of the purely African forms of life, it spells extinction. Like the rain-forest, they are doomed if the commercial exploitation of the continent continues to proceed upon the present lines. So far as the larger mammalia are concerned, the process is hastened considerably, of course, by the rifles of ivory hunters and sportsmen. Dr. Christy says:

"As an indication of the amount of ivory that has come, and comes, out of the Congo annually, I may mention that I have seen lying in a trader's store at Boga about fifty fine tusks. . . . The trader informed me that the collection was the result of a month's buying from the natives. He also said that he received an average of one ton of ivory per month, about seventy-five or eighty fair-sized tusks, from his Kifuku branch store on the Ituri River south of Irunu. His was only one of many scores, perhaps hundreds, of similar trading and collecting stores, at which ivory was the chief cause of their existence."

In view of what we have permitted in our own African possessions, we have no right to point an accusing finger at that Belgian enterprise to which Mr. Christy pays a high tribute. But no scientific man can contemplate the slaughter on such a scale of slow-breeding animals like elephants without realising that it must result in complete extermination. He thought too that, in spite of this butchery, and notwithstanding the great wealth derived from ivory, the material at present existing in our museums is wholly insufficient to enable the zoologist to determine how many species or sub-species of the African elephant would be recognised, or to obtain a detailed knowledge of its soft anatomy and skeleton, does not allay that feeling of resentment which must arise in every scientific breast.

It must not be thought that Dr. Christy shares the despondence of the reviewer. On the contrary, he right-heartedly treats of things seen and deeds done; despondence comes only with reflection and at a distance. In this book, Dr. Christy, while primarily concerned with the Ituri forest and its inhabitants, gives us the fruit of experience gained while engaged in general scientific and medical research or upon hunting expeditions in many parts of tropical Africa. To him is due the credit of making one of the finest zoological collections ever brought together from any part of Africa. This collection was made for the Belgian Government, and is now housed in the museum at Tervueren. It is especially rich in mammals. Of these, the smaller species were worked out in the British Museum by Mr. Oldfield Thomas, and as a result our national collection has been greatly enriched by the joint labours of the collector in the field and the systematist at home.

The chapters upon the okapi, the African elephant, and the African buffalo are of especial interest. Dr. Christy's views upon the status of the various forms of buffalo, illustrated as they are by numerous photographs and some most excellent maps, will merit and receive the serious consideration of all mammalogists busied with the African fauna. Many interesting observations upon other mammals, such as the forest hog, chimpanzi, bongo, duikers, aardvarks, ant-eaters, small mammals, and upon other vertebrates and insects, are also recorded. Chapters dealing with the skinning and preservation of specimens and with matters relating to forest-hunting and armament will be found useful by those who contemplate collecting trips in Africa.

Lastly, but by no means least, Dr. Christy's accounts of the Ituri pygmies and other native races will make a strong appeal to all interested in anthropology and ethnography. M. A. C. H.

The Study of Textile Fibres.

The Textile Fibers: their Physical, Microscopical, and Chemical Properties. By Dr. J. Merritt Matthews. Fourth edition, rewritten and enlarged. Pp. xviii + 1053. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 50*s.* net.

TEN years having elapsed since the appearance of the third edition of this well-known text-book on the properties of textile fibres, the author has, for the purposes of the present edition, been under the necessity of re-writing, re-arranging, and greatly enlarging the volume, which now runs to upwards of a thousand pages, with more than four hundred illustrations.

In order to estimate the degree of success which has attended the very considerable labours of the author, due regard must be paid to his assertion, in the preface to the present edition, that "the great majority of his readers are neither chemists nor scientists"; for it is to this majority that the appeal of the book is directed. These readers, presumably those engaged on the practical side of the textile industry, are given an admirable summary of information upon the properties and uses

of all the important textile hairs and fibres, which is marked by a praiseworthy attempt to incorporate the results of recent advances in textile research made both in Great Britain and on the Continent.

The magnitude of such an attempt will be fully appreciated by any one actively engaged in textile research, and, in the result, defects of arrangement and lack of balance in the treatment of the various portions of such an enormous subject as the textile fibres are only to be expected. For example, wool and silk are both treated in an adequate and well-balanced fashion which might well have served as a model for the treatment of the other important hairs and fibres. On the other hand, in spite of the importance of the linen industry and of the amount of recent work carried out, both in Great Britain and on the Continent, upon problems connected with the structure, retting, and mercerisation of flax fibres, linen is dismissed with a short chapter of twenty-two pages, while the relatively unimportant minor seed hairs have sixteen pages devoted to them.

Of the seven chapters assigned to the cotton hair, some are unnecessarily elaborate, while from others important omissions are numerous. Those on mercerised cotton and the chemical treatment of fabrics for water- and flame-proofing are almost complete enough to form part of a technical handbook on these processes. Moreover, in the former, descriptions are included of the processes of schreinering and emerising which have no connexion with the problem of mercerisation.

Turning to the omissions, no account of the microscopic structure of the cotton hair can be regarded as complete which does not adequately take into consideration the work of Balls and Denham. Yet the former receives scant attention, while the latter is almost ignored. Again, in the chapter on the chemical properties of cotton there is no mention of the results of recent important researches on the nitrogen content of the cotton hair, the determination of copper number and the absorption of methylene blue by cotton. From the summaries of the physical and physico-chemical properties of cotton, notable omissions are the results of recent work upon the lustre and regularity of yarns and the swelling of single cotton hairs in solutions of sodium hydroxide, all of which are problems of vital concern to the cotton industry and of fundamental importance in textile research.

The reasons for such omissions will be sympathetically appreciated by the research worker on textile problems. During the last five years, the whole appearance of the field of textile research has been altered, chiefly owing to the activities of the research associations of Great Britain, and one is driven to the conclusion that an adequate summary of the origin, properties, and employment in industry of cott linen, silk, wool, and artificial silk is now quite beyo the powers of a single author. Such a summary m not only be a record of progress in several wide fiel all of which are being actively explored in every dir tion, but must also, at the same time, remove from position where it affects the views of those who a "neither chemists nor scientists," a large amount pseudo-science which has established itself in t technical literature. For example, the problem mildew in cotton goods is one of very great econom importance in the cotton industry. Yet, in Chapter xv (pp. 554-555) of the volume under review, the fi portion of a section on the action of mildew in cott is not only quite inaccurate and unscientific, but is al substantially the same as has been transferred fr one technical handbook to another since the appearan in 1879 of "The Sizing of Cotton Goods" by W Thomson. The section is completed by the additi of recent work by Thaysen and Bunker (unackno ledged) on the application of the viscose swelling t to damaged cotton, and of Denham on the destru tion of cotton hairs by micro-organisms. To t uninstructed all this work is of equivalent value.

The information on commercial varieties of cott in Chapter xii. might have been more carefully check No account is given of contemporary progress a tendencies in the cultivation of cotton within t British Empire and in Egypt; nor is it now qu correct to state that "India is destroyed as a possil source of supply [of long staple cottons] for the Engli mills." Such cottons are now being successfully rais in the Punjab and are rapidly bought up when ava able. Egyptian cotton is also dealt with in an inad quate manner. Hindi cotton is actually given as o of the principal varieties grown in Egypt, whereas has long been known as a pestilential weed-cott causing endless trouble in the cotton field, owing to t ease with which it crosses with cultivated varieties.

The chapters dealing with the properties and analy of jute, ramie, hemp, and the minor vegetable fib are particularly well done, and, with their illustratio represent a great advance on previous works. Th upon the analysis of textile fibres, fabrics, and yar and the testing of textile fabrics are similarly wort of praise; although a more systematic arrangement the tests would have been possible and some discussi of their comparative values useful.

In a work of such importance, errors and mispri should be lacking. During perusal a number have be noticed, *e.g.* the length of individual cotton hairs p. 339 is given as ranging from $1\frac{1}{2}$ to $1\frac{3}{4}$ inches; Nub cotton is spelt Unbari (p. 389); Smyrna cotton included as African (pp. 391 and 414); the diameter

sland cotton is given as 9·65μ (p. 414), whereas it d be at least 50 per cent. greater; the cross- ns of cotton hairs given in Fig. 201 are mostly e any ever seen by the reviewer, while the sections n in Fig. 186, p. 414, are those of hairs which have been partially mercerised. A misprint on p. 787 the diameter of ramie fibre as ranging from mm. to 0·06 mm. Such minor defects might be nated from subsequent editions.

F. SUMMERS.

Some Applications of Psychology.

Applied Psychology. By Prof. Bernard C. Ewer. . xii + 480. 10*s*. 6*d*. net.

How to Experiment in Education. By Prof. William McCall. (Experimental Education Series.) Pp. + 281. 12*s*. net.

Intelligence Measurement: a Psychological and tistical Study based upon the Block-design Tests. Prof. S. C. Kohs. Pp. xii + 312. 14*s*. net.

The Psychology of Algebra. By Edward L. Thorn- ke, Margaret V. Cobb, Jacob S. Orleans, Percival Symonds, Elva Wald, and Ella Woodyard. Pp. + 483. 12*s*. net.

(New York: The Macmillan Co.; London: acmillan and Co., Ltd., 1923.)

EVERY man considers himself an expert on psychological matters and is ready and willing ve his opinions. "Psychological" is a word used misused countless times to connote the human or ular side of any activity, until its scientific implica- is often buried under a sea of colloquial general- ons. No other scientific worker suffers, to the same ee as does the psychologist, from the unsought-for ularity of his subject. The chemist does not see emical Drama" staring at him from the posters he daily papers, nor does the geologist find a plex geological hypothesis used as a subject of ving-room conversation. Such general interest has en aroused in psychology that quacks and charlatans n it to their financial advantage. Prof. Ewer is ently smarting under these popular misrepresenta- ns of the subject. Again and again in his "Applied chology" he harps on the need for caution in accept- psychological beliefs. "As in the case of many nther development in the history of culture," he es, "this one has been characterised by great husiasm, overweening confidence, and a somewhat ritical evaluation of results. Gradually, however, see the ebullient assurance giving way to a more atious spirit of inquiry, the glittering but unsubstan- froth of superficial investigation disappearing, and olid precipitate of valuable information settling."

(1) Prof. Ewer has set himself the difficult task of writing a book which shall pass between the Scylla of technicalities intelligible only to the expert and the Charybdis of popular over-simplification, and he has succeeded singularly well. The book is divided into four parts covering the main field of applied psychology: "Aims, Principles, and Methods," "Education and Everyday Life," "Mind and Health," and "Industry and Commerce." In the first more general portion, the author gives an introduction to the chief mental factors and the methods of their interpretation and control. The rest of the book is devoted to a description of their practical applications. This is fascinating reading and is of immediate use as well as of interest, for every one will find some advice applicable to himself. Prof. Ewer has not originated any great new schemes for training or curing the mind, but he gives a clear and impartial account of the main theories on these matters. He is fully alive to the dangers of the various applications of psychology and shows how to avoid their abuses as well as how to promote their beneficial effects.

Especially interesting are the chapters on "Intellectual Efficiency" and "Everyday Psycho-therapy." Here, as in all his work, Prof. Ewer keeps as close as possible to common experience. As he says: "Psychology often succeeds only in giving precise form to what wise persons have long known, or reasons for what they have always done; but it is none the less desirable to have such exactitude and rationality scientifically established." If every one was to read this book before airing his views on applied psychology, there would be much less inconsequent babbling.

(2) "How to Experiment in Education" is a book that will save young educational psychologists from many a weary hour and tedious mistake. Prof. McCall has succeeded in summarising his experience in such a manner as to hand it on to those starting in his field. It is almost as if one is buying experience with the 12*s*. that is the cost of the book. The author remembers his own difficulties when his professors trusted to his "genius to supply the missing half of research methodology." "There are excellent books," he writes, "dealing with the statistical manipulation of experimental data, but there is little help to be found on the methods of securing adequate and proper data to which to apply statistical procedure. Training is given and books exist only for the last step of a several step process. As a result, the final step often becomes little more than statistical doctoring for the ills in the data." Prof. McCall starts, therefore, at the very beginning and gives advice as to the selection and formulation of the experimental problem and the procedure of making a bibliography. His fundamental criteria for constructing a test are particularly helpful.

Psychological research has the peculiarity, compared to other scientific research, that its subjects are human and bear human relationships to the investigator and each other. Prof. McCall gives good advice as to the errors that arise from the faulty selection of the subjects, from the bias of the experimenter, and from other important causes. About half the book is devoted to comparing the three fundamental experimental methods : the one group method, the equivalent group method, and the rotation method. The author discusses their various uses and gives a chapter to the computations for each method. A useful chapter is also given to "Casual Investigations," in which standardised methods of observation are suggested when experimentation is for some reason impracticable. The book concludes by discussing twenty-eight typical experimental problems, showing the best method to apply to each. The author has attempted to make his book particularly clear and concise by expressing all relationships by formulæ, but here perhaps he rather defeats his own ends, as the abbreviations used necessitate a three-page key.

(3) The position of intelligence tests is now thoroughly established, and it is acknowledged that they form a means of obtaining a quick and trustworthy measurement of an individual's general ability. Until recently, most intelligence tests have had a linguistic bias, but it is now realised that some people can do themselves justice more adequately when dealing with things rather than with words. Several practical or "performance" tests have been standardised with varying degrees of success, and some were used in the giant investigation of testing the whole American Army. There is, however, a great need for additional trustworthy tests of this type. Dr. Kohs has limited his book "Intelligence Measurement" to a description of a series of block-design tests devised by him, which he has proved to give results corresponding closely to other criteria of intelligence. The tests consist of a series of coloured blocks which must be put together to make patterns of such varying degrees of difficulty that some can be passed by a five-year-old child and others are difficult for an adult. The technique of standardising the tests is extremely well described, and the ninety tables of figures in the explanation should serve as a warning to those who believe that to devise an intelligence test it is only necessary to think of some questions and give them to a few children.

(4) Any teacher of algebra, whether he started this term or has had forty years of experience, will be stimulated by reading Prof. Thorndike's "Psychology of Algebra." Experimental proof is worth a lot of theorising, and this book is the outcome of large scale investigations on many aspects of the subject. Many of the topics are quite original, but the more fam problems, such as the best order of presenting ma and the optimum distribution of practice, are neglected. An interesting study is made of the us algebraical knowledge to science students. *Quest naires* were sent to lecturers of the various physical social sciences, and text-books were analysed to see relative practical value of the different algebraic to But although such applications of the subject studied, its intrinsic value is also realised—the ap of "the love of thought for thought's sake by those can play the game of thought well."

WINIFRED SPIELMA

The Cactus Family.

The Cactaceæ : Descriptions and Illustrations of Pl of the Cactus Family. By N. L. Britton J. N. Rose. Vol. 4. (Publication No. 248.) vii + 318 + 37 plates. (Washington : Carnegie I tution, 1923.) 6.50 dollars.

THE issue of the fourth volume of "The Cactac brings this sumptuous monograph of the fa to a conclusion. Previous volumes have been cussed in NATURE, vol. 107, p. 580, and vol. 111, p.

Vol. iv. is carried out in the same excellent ma as the preceding volumes, and completes the acc of the smaller and more popular species of this fan It deals with the remaining three subtribes, nam the Coryphanthanæ, consisting of 14 genera, of w the principal is the familiar genus Mammillaria (he renamed Neomammillaria); the Epiphyllanæ, sisting of 9 genera, which of all Cacti are probably greatest favourites with horticulturists ; and Rhipsalidanæ, consisting of 8 genera. There is als appendix and an index to the whole work. The vol is beautifully illustrated with 37 fine plates, mos them coloured, and 263 figures in the text. references are also given throughout the work figures that have appeared in other books.

Altogether (including two new genera and 24 species described in the appendix) this volume tr of 33 genera and 358 species, the largest genera b Neomammillaria, 150 species ; Rhipsalis, 57 spec Coryphantha, 37 species ; Epiphyllum, 16 species ; Thelocactus, 12 species ; 14 genera are monotypic, the others have only 2-8 species each. In the er work, 124 genera and 1241 species are described illustrated by 137 plates and 1119 figures ; of thes considerable number are described and figured as

About two-thirds of the species dealt with in present volume belong to plants known in gar under the generic names of Echinocactus and M millaria ; the latter name, however, has now

d by the authors to Neomammillaria, because the
Mammillaria properly belongs to a genus of
It is unfortunate that previous monographers
ti had not long ago recognised this and changed
me in accordance with the rule of priority, for the
Mammillaria has become so firmly established
oks and gardens for these Cactaceæ that it will
ficult to supplant it by the new name.

other generic change of name, now rightly made,
ought to have been done long ago by previous
graphers, is to retain the name Epiphyllum,
was first published in 1812, for those plants
n in books and gardens under the name of Phyllo-
s, which was not published until 1831. The
s known in books and gardens under the name of
hyllum belong to the genera Zygocactus and
mbergera.

the genera, 12 are published in this volume for
irst time, and there are 3 others that have been
shed elsewhere since the issue of the first volume.
ough some of the genera in this work will probably
e upheld by future workers, the authors have con-
ntly followed their plan of utilising all vegetative
structural characters that differ in degree or nature
he formation of genera, with the result that the
es having the same characters in common are
ciated together in a more complete manner than
erto.

he authors deserve the hearty thanks of all lovers of
i for the admirable and efficient manner in which
have completed their task. In doing this they
e fortunately been better equipped for it than any
ious monographers of the group. For not only
e the authors themselves visited some of the regions
re these plants grow, and studied them under
ural conditions, but they have also received great
from many others interested in the group who reside
r have visited the various countries in which Cacti
w wild, and have contributed quantities of living
erial, photographs, and information appertaining
hem, all of which has been utilised in constructing
fine monograph; the result being that, not only
the first monograph of Cactaceæ that has been
lished in the English language, but is also one that
ir in advance of the German works upon the subject
t have hitherto held the field.

t cannot be expected that a work of this kind is
hout errors, but to the knowledge of the writer the
thors have done their best to avoid them. The
thing wanting appears to be a series of plates
rly illustrating the distinctions between the various
era. Perhaps the authors may see their way to
ply them as a supplement.

N. E. Brown.

Our Bookshelf.

The Work of the Royal Engineers in the European War, 1914–1919. Work under the Director of Works (France). Part 1: Historical; Part 2: Technical; Part 3: Maps and Plates. (Published by the Secretary, Institution of Royal Engineers, Chatham.) Pp. viii+279+6 maps+81 plates. (Chatham: W. and J. Mackay and Co., Ltd., 1924.) 21*s.*

This volume from its very nature lacks some of the thrilling interest which characterised some of the earlier volumes of the series to which it belongs, owing to the fact that it deals with a struggle against difficulties carried out for the most part at a distance from the enemy. When enemy action upset the plans of the Director of Works it was, save in the case of the bombing of hospitals, power stations, or important bases, generally due to a change in the plans of the whole army, in which the Director of Works had become necessarily involved. The struggle outlined in this volume is one to meet the demands of constant expansion and development with inadequate resources of labour, personnel, and equipment. Granted the conditions, it is marvellous how much was achieved and, on the whole, how successfully new demands were met.

The volume under review contains six chapters outlining the changes in each year of the War, the developments characteristic of successive phases, followed by twenty-five chapters of a technical nature discussing the separate branches of work for which the Director of Works became responsible. It is well illustrated by maps of the lines of communication areas, and by numerous diagrams of camps, larger buildings, huts, machines, and plant of various types. Much useful information is given about such items as camp sanitation, disinfection, and protection against hostile aircraft. On the whole, the book is of the nature of a technical guide to the engineer officer who is concerned with the design of camps.

The human element is rather lacking in the book, though we may mention the consternation caused among the inhabitants of Rouen when it was discovered that the goats in the Halle des Blés, protected from inclement weather by shutting all doors and windows, needed ventilation, and when on the windows being opened the pent-in effluvium of the goats rushed out and spread about the neighbourhood. Another human touch is supplied by the provision that on the lines of communication all hospitals *must* be lit by electric light, ammunition, supply, and ordnance depots *should* be lit, and camps, remount depots, and veterinary hospitals *might* be lit, if a supply could be obtained locally at a reasonable cost.

Die Entfaltungsbewegungen der Pflanzen und deren teleologische Deutung. Ergänzungsband zur "Organographie der Pflanzen." Von Prof. Dr. K. Goebel. Zweite, neu bearbeitete Auflage. Pp. x+565. (Jena: Gustav Fischer, 1924.) 20 marks.

The work of Prof. Goebel, of the University of Munich, is known to all students interested in the morphology and physiology of plants. His "Organographie der Pflanzen" was translated into English

by Prof. (afterwards Sir) I. B. Balfour and published by the Clarendon Press, vol. i. in 1900, vol. ii. in 1905. Since these dates a new German edition has been appearing (1913–23), and to it there was added in 1920 a supplementary yet independent volume dealing with the movements of attached plant-organs. The first edition of this last volume was quickly exhausted, and a second, considerably enlarged, has now been issued.

Much of Prof. Goebel's work can be described as a synthesis of morphology and physiology, and the present work is no exception. Here, however, the author has set himself a definite problem, namely, to investigate the kinds and methods of movements shown by plant-organs, and especially to decide whether or not they are adaptational. The word "Entfaltungsbewegungen" would seem scarcely to cover all the contents of the book, for the stimulated movements of floral parts and of sensitive plants, and also "sleep-movements," are considered, in addition to movements connected with the unfolding, growth, and development of buds, leaves, and flowers. The various movements are fully described in the text, which is illustrated by 278 figures, more than half of which are reproductions from photographs.

The number and variety of species on which observations are recorded, and on many of which experiments were made, enable Prof. Goebel to put forward his views with some confidence, albeit he is not dogmatic. Throughout the work he is decidedly sceptical concerning the various teleological theories which have been proposed, largely under the influence of Darwinism, as explanations of the movements of plant-organs. Unavoidable reaction, not purposeful response, is suggested again and again. That the movements often are relatively advantageous is not to be denied, and it may be granted that Natural Selection would tend to eliminate any species which had developed decidedly disadvantageous movements, but the advantages or disadvantages are secondary, not the purpose of the movements the origin of which has been fortuitous. Goebel further emphasises the manifold ways in which the movements of plant-organs occur, and it seems possible that the usual classification is misleading and has itself suggested false teleological conclusions. At least, the extensive studies which have been published by Prof. Goebel indicate that generalisations based on limited, even if intensive, observations and experiments may often prove false. W. B. T.

Medical and Veterinary Entomology: a Textbook for Use in Schools and Colleges as well as a Handbook for the Use of Physicians, Veterinarians and Public Health Officials. By Prof. William B. Herms. Second edition, completely revised. Pp. xv+462. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 28*s.* net.

In the second edition of this work the chief new features are the historical introduction, dealing with the development of medical entomology, and the additions to various chapters of material derived from the author's experience as a sanitary officer in the U.S. Army during the War. The external features used in classification and the life-history of the insects of medical and veterinary importance are considered, but internal anatomy is dealt with only in a few ca Methods of control are carefully discussed, references given in the most important cases to original sources of the respective methods. The n detailed chapters are those devoted to lice, mosquit house-flies, larvæ which produce myiasis, and ti and these are the chapters which will be most usefu the majority of readers. The accounts of other inse *e.g.* fleas, are less satisfactory from the medical p of view; thus, although the characters of *Xenops cheopis* are given there is no reference to *X. astia* o *X. brasiliensis*—which the reader should be sh how to differentiate from *X. cheopis*, and the aut is in error in regard to the structure labelled as hy pharynx in the figures of the fleas shown on p. In the brief account of the life-history of *Dipylid caninum* the work of Joyeux (1916) might have b referred to. The observations of Dr. and Mrs. Cor (1922) on the life-cycle of *Filaria* (*Loa*) *loa*, and work of Christophers (1922) on the segments of mosq larvæ, were perhaps published just too late to rec notice. In the description of Fig. 20 the term p (of the house-fly) should be replaced by pupari Good drawings would have been more helpful to reader than certain of the photographic illustrati provided, *e.g.* Figs. 91, 140, 141, 143, 152, 161, 180, 210.

The book has no doubt been written with partic reference to the needs of medical and veterin students and public health officials in the United Sta but the greater part of the work has a general appl tion to the conditions in warm climates elsewhere, will be found useful by those who desire a con account of the biology and methods of control of insects which attack man and animals.

A Third Year Experimental Chemistry. By W. Crabb. Pp. viii+247. (London: Mills and B Ltd., n.d.) 3*s.* 6*d.* net.

On leaving the university and entering a second school to teach science, the young graduate quic finds that he has much to learn, and as he progre he realises more and more the folly of spoon-feed his pupils on "academic" science. If he is keen progressive, he will construct his own notes and p together the scaffolding of a potential text-book; in compiling such data he will gather valuable perience. Whether his work will be published not depends upon many factors: ambition, the s regarding instinct, inertia, modesty—and publishers

The small work under review appears, rightly wrongly, to have originated in some such manner the above, and it will be very useful not only to author, but also to other teachers, if they do not pr their own notes. The author is evidently a clear conscientious teacher, and the only adverse criticism be offered is that he covers too much ground; w the exception of pupils who are specialising betw 17 and 19 years of age, it is very doubtful if any ordin school class could adequately assimilate more than the contents of this book in a working school year, s of 30 weeks; and probably only a small minority pupils could tackle the work successfully after a t years' course in elementary chemistry. To take

on as an example. The sixth lesson, on diffusion liquefaction of gases, comprises revision of experi-nts on these subjects, Graham's law, and practical olications; then some historical notes leading to a y sketchy notice, without diagrams, of liquefaction gases by self-cooling; and lastly, as "topics for cussion," commercial liquefaction of gases, separa-n of oxygen and nitrogen from liquid air, uses of uid air, methods of nitrogen-fixation, uses of liquid phur dioxide, chlorine and ammonia, carbon-dioxide now."

t is regrettable that attempts are still made in our ools to turn out ready-made chemists and physicists. lightened university teachers, and employers, do not nt students of this kind; they want youths with ute and alert minds, having a sound knowledge of mentary principles and a keen desire for more.

abische Alchemisten. 1: Chālid ibn Jazīd ibn Mu'āwija. Von Julius Ruska. (Heidelberger Akten der von-Portheim-Stiftung, Heft 6.) Pp. 56. (Heidelberg: Carl Winter's Universitätsbuchhandlung, 1924.) 3 marks.

his scholarly dissertation upon Khalid ibn Yazid will ceive a hearty welcome from all those who are terested in the history of chemistry. It must serve a foundation for all future work upon Khalid, who is e of the most attractive of early Muslim chemists. uch that is legendary has been associated with him om a very remote period, and this apocryphal matter ls naturally increased with the passage of time. rof. Ruska carefully examines the principal sources ir the life of Khalid and is able to show that they ntain numerous inconsistencies and anachronisms. is clear that none of them is entirely trustworthy, ad the same may be said of the various books and oems in Arabic ascribed to Khalid, which are probably ll spurious, even though they may contain authentic assages.

Prof. Ruska considers the Khalid-Morienus story at me length, and rejects it. He explains that in its arliest form the story makes Stephanus, contem-brary with Herakleios (died 641), the teacher of halid (died 704), but suggests that when Muslim istorical knowledge came to recognise that Stephanus ad died before Khalid was born, a "pupil of tephanus," Marianus or Morienus, was invented to ct as a link between the two.

All the Latin works which pass under the name of halid or Morienus are declared by Ruska to be alsifications, particularly the "Liber Secretorum Artis ompositus per Chalid filium Jaichi," and "Liber rium Verborum Kalid Regis acutissimi." While this s probable enough, there is good reason to suppose hat certain sections are of extremely ancient origin, as hey may be found in Arabic in the "Kitāb al-Muktasab" (*c.* 1300), which goes back to "Ares" and Khalid for its authorities and is quite independent of he line of development passing through Rhazes and he Spanish Arabs.

One small error may be noted. On p. 49, Prof. Ruska attributes the "Rutbatu'l-Ḥakīm" to Maslama al-Majriti; it was in fact written about 100 years after Maslama's death. E. J. H.

The Fauna of British India, including Ceylon and Burma. Edited by Sir Arthur Shipley. *Birds.* Vol. 2. By E. C. Stuart Baker. Second edition. (Published under the authority of the Secretary of State for India in Council.) Pp. xxiii + 561 + 8 plates. (London: Taylor and Francis, 1924.) 30*s.*

THE second of the volumes on Indian birds undertaken by Mr. E. C. Stuart Baker, for the "Fauna of British India" series, is a worthy successor to the first. It contains a further instalment of the Passeres from the Cinclidæ (Dippers) to the Regulidæ (Goldcrests, etc.), and deals with 473 forms in a remarkably thorough manner. So far as is known, the vernacular names, nidification, and habits of each form, in addition to a complete systematic description, are given, and it is hoped that further observations under the first three headings will be recorded by Indian ornithologists. A noteworthy feature, as in the first volume, is the numerous coloured plates executed by the author himself, which are a credit to his artistic ability. A few eggs and nests might with advantage have been figured; a series of the former as a coloured plate would have made a fitting frontispiece, or a figure of the egg of each of the forms of which plates have been given might have been included in them. The absence of a full synonymy is again noticeable, but we learn with satisfaction that a sixth volume has been sanctioned which will contain a full synonymy of the forms dealt with in the previous volumes, and such addenda and corrigenda as are necessary.

The "Fauna of British India" series is, we believe, meant primarily to serve as complete handbooks on various groups for Indian collectors, and if this object is to be fulfilled in dealing with the birds, Mr. Baker would do well to take the opportunity of introducing a brief but complete introduction to Indian ornithology, containing notes on collecting, geographical distribution, and a map, with some account of the topography of the region insomuch as it concerns the Indian birds, in the sixth volume of his series. Mr. Baker's extensive knowledge of Indian field ornithology would make such an introduction most valuable. He is to be congratulated on producing a series which again makes it possible for those who have not his special knowledge to identify Indian birds correctly without wading through a mass of confusing synonymy.

C. DOVER.

Engineering Non-Ferrous Metals and Alloys. By Leslie Aitchison and William R. Barclay. (Oxford Technical Publications.) Pp. xx + 300. (London: Henry Frowde and Hodder and Stoughton, 1923.) 21*s.* net.

A TRUSTWORTHY account of the non-ferrous metals and alloys used for engineering purposes has been needed for some time, and Dr. Aitchison and Mr. Barclay have made an excellent effort to meet this need. Without entering into processes of manufacture, they discuss generally the properties of cast and wrought metals, and then describe in detail the several metals and alloys with their physical and mechanical properties, together with their principal uses. The statements of the authors are based on a wide practical experience, and may be regarded as authoritative. The section on the alloys of nickel will be found

particularly valuable. The metallographic side of the subject is less fully dealt with, and the photo-micrographs included do not constitute a representative series. The equilibrium diagrams might well have been omitted, as they bear no indication of the phases present, and the copper-aluminium diagram on p. 125 is impossible. The engineering reader would not derive any information from such diagrams, and the metallurgist would have to look elsewhere for an explanation of them. Mechanical testing is well and clearly described, but it is rather surprising that the now familiar Erichsen test is not included, it being greatly superior to the crude cupping test.

The book was completed too early to admit of the incorporation of the detailed report of the Alloys Research Committee on light aluminium alloys, but we may expect that this section will be expanded in a future edition. The same may be said of the die-casting alloys, as to which more information is now available than the authors have provided. It is certain that the book will be welcomed by engineers, and will be found useful by metallurgists.

The Literature of the Charadriiformes from 1894–1924: with a Classification of the Order, and Lists of the Genera, Species, and Sub-species. By Dr. George C. Low. Pp. xi+220. (London: H. F. and G. Witherby, 1924.) 12*s.* 6*d.* net.

Much labour has obviously been expended in the preparation of this work of reference, and ornithologists must be correspondingly grateful to Dr. Low for his having placed so useful a tool in their hands. Its purpose is to supply a complete guide to the literature dealing with the Charadriiformes in the thirty years which have elapsed since the publication of volume xxiv. of "The British Museum Catalogue of Birds." The labours of other workers in this field will be greatly facilitated by the availability of these collected and classified references. A preliminary chapter discusses the classification and nomenclature of the group, and a second gives references to works of a general kind bearing on the subject. The rest of the book is devoted to references grouped under the names of the ninety-seven genera, in ten families, which Dr. Low admits to the order, and under each genus they are arranged chronologically. Some idea of the bulk of modern ornithological literature may be gathered from the fact that the references to this one order, admittedly an important and interesting group, fill about two hundred pages. Frequent use in actual work is the only true means of testing a book of this kind, but such checks as one can readily impose show that Dr. Low has performed his laborious task with the thoroughness and accuracy for which it called.

The Irish Setter: its History and Training. By Colonel J. K. Millner. Pp. 80+8 plates. (London: H. F. and G. Witherby, 1924.) 5*s.* net.

From the introduction we learn that this is the first book devoted solely to the Irish setter. It cannot, however, be regarded as more than a random collection of miscellaneous notes about the breed, and some of its most distinguished representatives, with an admirable chapter on training and a clear description of the points of the breed as approved by the Irish Red Setter Club. The origin of the Irish setter is apparentl shrouded in oblivion. Beyond the suggestion that i has been derived from the red spaniel of the eighteent century, used largely in hawking, and that its develop ment dates from the beginning of the practice o shooting at flying birds in the last half of the sam century, there is nothing really definite that is known and no records are available which help to establish it history. A century ago there were apparently tw distinct strains—red, and red and white, the latte predominating; but with the introduction of dog show and the somewhat arbitrary requirements of fanciers the red-and-white strain has largely disappeared. Fo show purposes only the merest traces of white on th head, chest, throat, and toes are allowable. Mr. S. W Carlton contributes the introduction, and the book i illustrated by eight half-tone blocks of celebrated Iris setters, taken from the dogs themselves or from o paintings.

Automatic Telephones. By F. A. Ellson. (Pitman' Technical Primers: Double volume.) Pp. xii+215 (London: Sir Isaac Pitman and Sons, Ltd., 1924. 5*s.* net.

At first sight, automatic telephony appears to be hopelessly complicated subject. Yet next year it wil be necessary for all telephone subscribers to begin t get a working knowledge of it, as the British Post Offic decided a year ago that automatic equipment is to b adopted in all important areas. We wonder whethe in the future it will be well known that the "doubl dog" is knocked away until the wipers clear the bank and that during this process the stationary dog support the weight of the shaft. In any case these terms wil have to be included in technical dictionaries. The lis of British standard terms made by the Engineering Standards Association and included in this volume i excellent. The advantages of the automatic syste are the large savings that can be effected in the annua charges, the continuous day and night service, and th increased efficiency and accuracy. The disadvantage are the greater capital cost and maintenance charges and the increased liability to faults at the subscribers end. To the intelligent reader who wishes to under stand the basic principles of the ordinary systems i use, we can recommend this book.

Anatolica. By Harry Charles Luke. Pp. xii+210+ 40 plates. (London: Macmillan and Co., Ltd. 1924.) 16*s.* net.

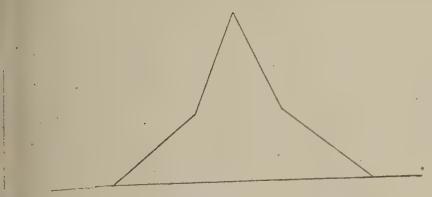
In this volume Mr. Luke again shows the knowledg and insight, together with the charm of style, that have made notable his previous volumes on the Near East. Among the flood of books on various parts of the eastern Mediterranean, it is rare to find one written with more authority or marked by greater conciseness and first-hand observation. It is entirely unpolitical, and consists of a series of short essays on various towns and districts, including Mount Athos, Salonika, Adrianople, Cyprus, the Holy Sepulchre, Petra, and the cities of Transcaucasia. The chapters on Cyprus are among the most vivid in the book, and recall the charm of the island. There is a quaint and sufficient map, and the illustrations are well chosen. The coloured frontispiece of Mount Ararat is excellent.

Letters to the Editor.

Editor does not hold himself responsible for nions expressed by his correspondents. Neither he undertake to return, nor to correspond with writers of, rejected manuscripts intended for or any other part of NATURE. *No notice is en of anonymous communications.*]

pecific and Latent Heats of Iron and Steel.

a letter on this subject published in NATURE of 19 (vol. 113, p. 566) it was shown that if the *rature* of the metal is raised continuously, the ting expansion plotted in terms of time appears smooth curve exhibiting no peculiar features.[1] on the other hand, *heat* is supplied in the same the variation of temperature, and therefore of nsion, is dependent on the specific heat of the

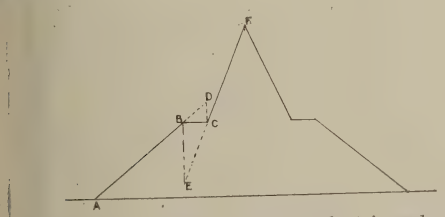


—Diagrammatic representation of the extension of a material when at is supplied and withdrawn at a constant rate; and the specific at changes at a definite temperature.

rial so that the rate of extension is (*cæteris ous*) inversely as the specific heat.

I the rate at which heat is supplied is uniform, if the only change in the metal at the critical perature is in the specific heat, the curve repre- ng the extension during a cycle of heating and ng would be four straight lines as in Fig. 1.

I however, in the change from the low to the high perature state, heat is rendered latent,[2] and pro- d that the change can be brought about by an finitesimal excess of temperature above the critical le, the extension diagram will be of the form n in Fig. 2.



2.—Conditions as in Fig. 1, except that heat is rendered latent at e temperature of the change of specific heat. The quantity of heat hich becomes latent is equal to that which would raise the temperature fficiently to cause the extensions CD or BE, according as the specific eat is taken as that belonging to the branch AB or CF.

he latent heat is that which would cause an ex- sion CD or BE, according as the specific heat is ln as having the low or high temperature value. Vhen, as in my experiments, the variation of tem- e ture in heating depends on the excess of heat plied over that lost by radiation and convection, n in cooling on the difference of temperature eveen the heated wire and its surroundings, the traight lines in Figs. 1 and 2 become exponential curves, and the typical heating and cooling diagram is similar to that in Fig. 3.

The curved form of the junction between low and high temperature branches shows that the material is in an unstable condition at the critical temperature, and that to start the transition from one state to the other, the critical temperature must be exceeded in heating, or passed in the opposite direction in cooling, but that once started it proceeds in suitable conditions, with sufficient rapidity to reduce or raise the temperature of the wire, and thereby alter its length. To show these effects to advantage the diameter of the wire must be small enough to ensure that the difference of temperature between its surface and interior is small.

In the letter of April 19 previously alluded to, it was shown that the critical temperature was chiefly dependent on the proportion of carbon present in the metal, and it was suggested that in iron free from carbon the critical temperature might be found to be that corresponding to the intersection of the curves appropriate to the two specific heats. A reference was also made to the difficulty of obtaining iron containing no trace of carbon.

It seemed possible that such iron might be prepared by the "Thermit" process, and within the last few weeks I have experimented with wire drawn from an ingot of Thermit iron made at the Davy-Faraday Laboratory from pure materials. Lengths of this wire were heated with graphite for various periods in

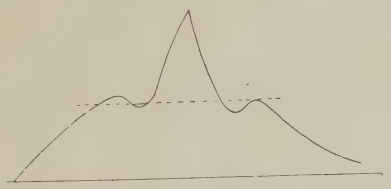


FIG. 3.—Diagram of the extension of the same material as that of Fig. 2, when the net increment of heat is proportional to the excess of heat supplied above that lost in the same time by radiation, etc., and the loss of heat during cooling is proportional to the excess of the temperature of the material above its surroundings.

a combustion furnace, and the results of these trials are shown in Fig. 4.

It should be stated that the analysts find that the Thermit ingot contained something like 0·04 per cent. of carbon, and also that in a sample of electrolytic iron which the National Physical Laboratory were kind enough to supply the carbon percentage was 0·065.

In both cases the origin of the carbon is unknown. An examination of the curve in Fig. 4 shows that even a thirty minutes' heating in graphite causes a slight drop in the critical temperature and some change in the character of that part of the curve which indicates the extension while change of state is in progress.

These changes become more marked as the time of heating in graphite is prolonged, and when this reaches five hours, it is seen that there are two separate pauses at different temperatures in the heating curve and a double reheating during cooling.

All these peculiarities can be explained by supposing that the outer parts of the wire have been converted into a mild steel while the core remains comparatively pure iron: so that each part changes its state at the temperature appropriate to its carbon content.

The diagram Fig. 4, *a*, for the Thermit iron which has not been in contact with the graphite, shows a critical temperature slightly higher than that for the "Armco" iron referred to in my letter of April 19, but in other respects the results are identical; and in

[1] he actual coefficient of expansion of iron at first increases with the erature, but diminishes as the melting-point is approached.

[2] t is not unlikely that something of the same kind happens with any ent which assumes an allotropic form on heating. If a small quantity f phur in the plastic state is "chawed," it soon resumes the crystal- n form, and becomes gritty in the mouth, with a very sensible rise of erature.

all the irons and steels I have used, the ratio of the low and high temperature specific heat is very nearly three to one.

In making steel by the cementation process on a commercial scale, I believe that iron bars exceeding 1 square inch in cross-section are heated in charcoal for a fortnight or more; and as the carbon probably passes into the metal by diffusion, it might be expected that in the case of an 0·02 in. diameter wire,

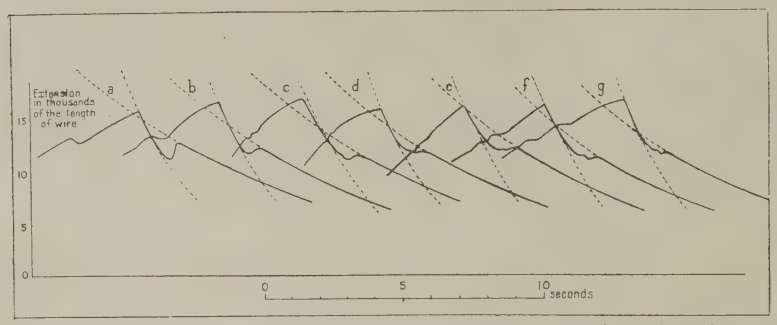


FIG. 4.—Tracings from diagrams of extensions during heating and cooling of wires drawn from "Thermit" iron, the wires being subsequently heated in graphite for the following time:

Diagram.	Minutes.	Diagram.	Minutes.
a	0	*d*	180
b	30	*e*	250
c	60	*f*	320

saturation would be reached in a much shorter time. It would seem, however, judging from the lower of the critical temperature in diagram *f* of Fig. 4, that the five hours' heating has only produced a coating of very mild steel. The temperature at which cementation is carried out probably has an important effect on the rate of diffusion, and further experiments on this subject will be made with purer samples of iron, if such can be obtained. A. MALLOCK.

9 Baring Crescent, Exeter,
August 8.

The Rotatory Dispersion of Tartaric Acid.

EIGHTY-EIGHT years ago, Biot (*Comptes rendus*, 1836, 2, 542) showed that an *anomalous* rotatory dispersion could be produced by superposing two *normal* partial rotations of opposite sign and of unequal dispersion. This general theory of the origin of anomalous rotatory dispersion can be developed in two ways, according as it is supposed that a partial rotation of opposite sign is produced as the result of a chemical change in the optically-active molecule, or that the presence of two opposite partial rotations is one of its inherent physical properties. In the Bakerian lecture of 1921 (Phil. Trans., 1922, A, 222, pp. 249-308) we adopted, for the case of tartaric acid, the former explanation.[1] This was in harmony with the conceptions of Biot himself, since he attributed the variations in the rotatory power of this acid, *e.g.* in aqueous solutions, to chemical and not to physical causes; this point of view had also been stated in a very precise form by Arndtsen in 1858 (Ann. Chem. Phys., 1858, 54, p. 421). The same explanation has since been adopted by Astbury (Proc. Roy. Soc., 1923, A, 718, p. 527; NATURE, July 26, p. 122) as a sequel to his X-ray examination of the crystals, and by Longchambon (*Comptes rendus*, 1924, 178, p. 951) as a result of his study of their optical rotatory power. There is therefore a strong consensus of opinion amongst all those who have recently worked on the subject, that the anomalous rotatory dispersion of tartaric acid is related very intimately to its ability to undergo a reversible chemical change.

[1] The latter explanation has been adopted in the case of α′-bromocamphor.

Whilst the existence of this chemical change admitted by all the workers named above, differen of opinion have arisen as to the exact nature of change. Arndtsen adopted a perfectly general v as to the nature of the dextro- and lævo-rotat components. In the same way, Longchambon (w identified the lævorotatory component with ordinary crystals of the acid, and named two components as α- and β-tartaric acid) offered opinion as to the nature of β-tarta acid. In the Bakerian lecture, h ever, after a careful study of all available evidence, we felt justif in concluding that the acid exists two *isomeric* forms of opposite rot ory power. Astbury, on the ot hand, postulated a reversible *p meric* change, depending on " tendency of the molecules to bu themselves up into a lattice . . . e in dilute solutions." This view been shown to be untenable in case of ethyl tartrate (Lowry a Cutter, Journ. Chem. Soc., 1924, pp. 1465-1470), where determi tions of molecular weight can made without the complicati which would arise from electrol dissociation in the case of the acid; and, although it is p fectly true that "the dextrorotatory system predominates in dilute solutions" of the free acid *water*, as required by Astbury's hypothesis, dil solutions in *acetone* are *lævorotatory* (Austin and P 1924, unpublished observations). The progressive composition of "crystal molecules" into "chemi molecules," which was first put forward by Land in 1879 as an explanation of the mutarotation of sugars, appears then to be equally invalid w brought forward again as an explanation of anomalous rotatory dispersion of tartaric acid.

Astbury suggests that the individual molecules tartaric acid contain an *intramolecular* spiral of f carbon atoms, which is *dextrorotatory*, whilst crystals contain also an *intermolecular* spiral (form by the juxtaposition of hydroxyl-groups in conti ous molecules) which is itself *lævorotatory*, but *always accompanied by the fully developed dextrorotat spiral*. Longchambon, on the other hand, suppo that whilst the *solutions* contain both a dextrorotat and a lævorotatory component, these are individ chemical compounds and may therefore be separa from one another; the *crystals* therefore contain o the lævorotatory component (α-tartaric acid), *dextrorotatory component (β-tartaric acid) having b eliminated completely during the process of crystalli tion.*[2] These conflicting views can be tested by amining the relevant rotatory dispersions. In case of aqueous solutions of tartaric acid, the rotat dispersion can be represented by the equation:

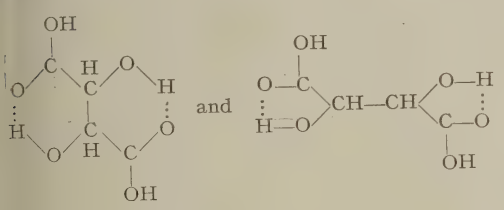
$$\alpha = k_1/(\lambda^2 - 0{\cdot}03) - k_2/(\lambda^2 - 0{\cdot}074).$$

The esters give similar equations but with rat smaller values for the second dispersion-consta If the lævorotatory crystals of tartaric acid gave o the negative partial rotation of the aqueous solutio (as Longchambon supposes), the dispersion-ra $\alpha_{4358}/\alpha_{5780}$ would be about 2·2, whereas *lar* values would be given if (as Astbury suggests) negative rotation were masking a smaller positi term. The ratio 2·14 actually observed by Lor chambon is almost identical with the value calculat from our equation, and therefore affords a conclusi

[2] Compare the complete separation of one of a pair of labile isomerides crystallisation from solutions of α-glucose or of nitrocamphor.

cation of his claim to have separated the lævo-ory component completely from the dextro-ory component which is formed from it in ion.

his original paper, Astbury ascribed the anoma-dispersion of tartaric acid to "strings of mole-, connected together at the hydrogen junctions" e hydroxyl-groups, which he represents as points ontact between contiguous molecules in the als, thus —OH HO.CO—. When it is realised the X-ray analysis of organic compounds deals with the orientation and spacing of *molecules*, gives no information as to the positions of the idual *atoms*, it may be doubted whether there is experimental foundation whatever for the wholly obable view that the molecules of tartaric acid held together *by the mutual attraction of two ms*. The idea that two hydroxyl-groups attract another is indeed an old one; but since Bragg blished the crystal-structure of ice, it has become nt that this action depends on a mutual attrac-between the hydrogen of one molecule and the gen of another, a view that has recently been de-ped under the title of "Bivalent Hydrogen" by . Lewis in America, and in Great Britain under itle of "The Co-ordination of Hydrogen" by one ne undersigned. Considerations of this kind have us to conclude that the anomalous rotatory dis-ion of tartaric acid and its esters probably nds on an interaction between the hydroxylic *ogen* and the carboxylic *oxygen*, giving rise to nal co-ordination-compounds such as



s conclusion is in harmony with the fact that the malous dispersion of tartaric acid persists in its rs, *in spite of the elimination of the carboxylic rogens*, which are essential to Astbury's hypo-is; it also agrees with the fact that all the malies disappear in the methylene ether (Austin Carpenter, 1924) in which the hydroxylic hydro-es (but not the carboxylic hydrogens) have been inated.

f, as may be gathered from his letter in NATURE of y 26, Astbury is anxious to lay stress on the fact t the forces which produce anomalous rotatory ersion in solutions of tartaric acid are identical h "the forces which bind the molecules into the rstalline structure," we should be in complete eement with him; but we should regard these es as depending on the simultaneous attraction a proton for two oxygens, rather than of two itons for one another.

T. M. LOWRY.
P. C. AUSTIN.

Spiral and Structureless Nebulæ.

N "Our Astronomical Column" of NATURE of Agust 2, reference is made to Prof. Perrine's letter o Prof. Lindemann's spiral nebula hypothesis which ppeared in the *Observatory* for July. As Prof. Lidemann's hypothesis was based to some extent o photographic observations of my own, perhaps I may be permitted to make a few comments on the matter generally.

Prof. Perrine's criticisms on the supposed reflection of light from the Galaxy are not new, and are practically covered by my paper on Prof. Lindemann's theory which appeared in the Monthly Notices of the R.A.S. for May last year. The observational facts are entirely against this part of the hypothesis, and I think I am not misrepresenting Prof. Lindemann when I say that he does not attach so much importance to the *source* of reflection as to the probability of reflection being the cause of the colour distribution. There are considerably more grounds for assigning the source of reflection (if any) to the bright central nucleus of the spiral itself. I found, for example, that the curve of light distribution in the nucleus of the Andromeda nebula (N.G.C. 224) was a near approach to the curve $(x+1)^2y = \text{constant}$; and Hubble has recently derived much the same result for a series of bright amorphous ellipsoidal nebulæ of non-galactic type, which have been photographed with the 100-inch reflector at Mt. Wilson. This applies to the amorphous or uncondensed type of spiral nuclei, but it does not apply to the condensed type of spirals where numerous condensations appear and the nucleus is weakened by continued outflow of matter along the spiral arms. In the latter case the peak of the curve is considerably flattened, and the non-luminous matter at the periphery of the nebula is taken up into the condensations.

It may be inferred from this that reflection as a cause of illumination is a possibility in the amorphous type but is definitely ruled out in the condensed type. This has led me to doubt the validity of the photographic observations on which Prof. Lindemann's hypothesis was based. The photographs which Prof. Seares obtained at Mt. Wilson with the 60-inch reflector were comparative—one with an unscreened ordinary plate and the other with a yellow screen and an isochromatic plate. These showed quite definitely for the condensed type a stronger image of the nucleus in the isochromatic than in the ordinary plate compared with the outer regions of the spiral, the inference being that outer regions of the spirals are deficient in the longer wave-lengths. The same results were found in my photographs of the uncondensed type which were measured with a photo-micrometer, and were also carried down to the red region of the spectrum with panchromatic plates and suitable screens. Some photographs were also obtained of the nucleus of the Andromeda nebula with ordinary plates and a nickel oxide screen to cut out the visual part of the spectrum and transmit the ultra-violet. It is evident, however, that we are dealing with plates having contrast factors which differ with the wave-length, and the variation found may be owing to a combination between the range of spectrum and the plate employed.

This question has been dealt with at some length by Ross (*Astrophysical Journal*, vol. 52, p. 86), who finds that the variation of γ (the contrast factor) along the spectrum is greatest for panchromatic plates and least for orthochromatic plates. He points out also that the depth of image in the ultra-violet is not so great as in the longer wave-lengths, which penetrate further into the emulsion. At the same time, I should not wish to condemn the observations out of hand as untrustworthy, but rather I would advocate the repetition of them under more rigorous conditions, which is quite possible, and would give us definite information on this important point.

J. H. REYNOLDS.

Low Wood, Harborne,
August 14.

The Production of very Intense Magnetic Fields.

In a letter to NATURE which appeared in the issue for April 19 last, I gave a brief outline of a method for producing very intense magnetic fields.

I have now made some measurements which show that magnetic fields of considerably greater intensity may be generated by this method than had appeared at first sight to be practicable. For example, in one test a magnetising solenoid wound with 25·5 turns per cm. was used, and the first peak value of the discharge current obtained when condensers of 700 micro-farads total capacity were used, charged to a pressure of 1850 volts, was found from the oscillograph record to be 12,500 amperes. *This means that an intensity of magnetic field of about* 400,000 *gauss was generated.*

By means of a modification of the apparatus which is now being effected, it is expected that an intensity of magnetic field of about 1,500,000 gauss will be obtained very shortly.

It is useful to examine what considerations govern

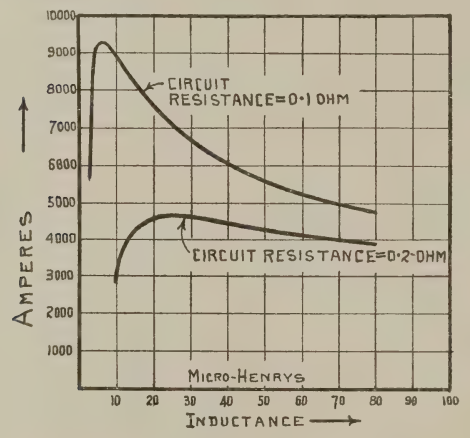


FIG. 1.

the maximum value of the condenser discharge current which can be obtained by this method. The magnitude of the first peak of the discharge current is given by the expression

$$\frac{V}{L\sqrt{\left|\frac{1}{LC}-\frac{1}{4}\frac{R^2}{L^2}\right|}}e^{-\frac{1}{2}\frac{R}{L}T} \text{ amperes,}$$

where

V volts is the pressure to which the condenser is charged.
L henry is the inductance of the circuit.
C farad is the total condenser capacity.
R ohm is the resistance of the circuit.
T second is the time for a quarter-period of the discharge current.
$e = 2{\cdot}718$ and is the base of natural logarithms.

In Fig. 1 the magnitude of the first peak of the discharge current is shown as a function of the inductance when the condenser capacity is 700 micro-farads and the pressure 2000 volts. Two cases have been selected, namely, (i.) for a circuit resistance of 0·1 ohm, and (ii.) for a circuit resistance of 0·2 ohm.

It is important to observe that the maximum value of the first peak of the discharge current is obtained for a definite value of the inductance, and that this maximum value is more sharply defined the smaller the resistance of the circuit. T. F. WALL.

Edgar Allen Research Laboratory,
University of Sheffield,
August 30.

Absorption of Vapours of Various Liquids by Cotton.

THE familiar absorption of water from the air cotton has been studied in our laboratories for so years from various aspects. The phenomena valuable as clues for interpreting the physico-chem structure of cotton cellulose; and in this connexi we have naturally examined the capillary hypothe using Anderson's formula for calculation of capill radii. We recently initiated a simple series observations which indicate that this hypothesis inadequate, by showing that the weight of vap absorbed is dependent on the chemical nature of t vapour, with a suggestion that there is a consta " low level " group, including definite types of liqui with which the values are due to simpler causes th with water or acetic acid, the values for the two lat being far higher. As the differences for vari liquids are very marked and do not seem to ha been previously recorded, the following particul may be of interest, in spite of the primitive meth used in what was merely a preliminary examinatio

Samples of unbleached and bleached twof Egyptian cotton hosiery yarn were suspended, at ro temperatures, in a bottle, in the bottom of which w a layer of the liquid under consideration. The cott (which before enclosure had been dried for four ho in a water oven and then weighed) was withdraw with suitable precautions, at intervals of seve hours and weighed in a weighing bottle. Curves w drawn through the plottings of these weight-values order to show approximately the variation of weig with time for water, alcohol, acetic acid, benze nitrobenzene, carbon disulphide, ether and aceto The following table shows only the saturation val at room temperatures:

Liquid.	Unbleached.	Bleached.
	Per cent.	Per cent.
Water	18 to 20	19 to 21
Glacial acetic acid	18 ,, 20	17 ,, 19
Absolute alcohol	3 ,, 3½	8½ ,, 9
Carbon disulphide	1½ ,, 2	1½ ,, 2
Benzene	1½ ,, 2	1 ,, 2
Ether	7 ,, 7½	7 ,, 7½
Nitrobenzene	1½ ,, 2	1½ ,, 2
Acetone	2 ,, 2½	6½ ,, 7

It is intended to investigate these phenome further in the Experimental Department of the F Cotton Spinners' and Doublers' Association, to wh I am indebted for permission to publish this note.

ROBERT C. BRIMLEY.

Rock Bank, Bollington,
near Macclesfield, Cheshire,
August 29.

The Magnetic Resolution of the Scandium Line

SEVERAL lines of the scandium spectrum have be classified by Catalán (An. Soc. Esp., 20, 606, 19 and 21, 464, 1923). According to him, the Sc spectrum contains a doublet- and a quartet-te system; the Sc II. spectrum a triplet-system. It however, probable that some corrections must made in his term-scheme. These corrections obviously also made by Gieseler and Grotrian (*Natur* 12, 438, 1924).

We have made provisional measurements of t magnetic resolution of some scandium-lines. means of the formulæ given by Landé (*Zeit. f. Phy*

[illegible]39, 1923), it has been possible to calculate the [illegible]er part of these resolution patterns from the [illegible]ted term-scheme. The observations agree com[illegible]ely with the calculations on the assumption that [illegible]rdinary formula for the "separation factor" g [illegible]ndé is valid.

[illegible]e observations of a few other lines make it not [illegible]obable, however, that there may be some terms [illegible]hich the ordinary formula does not apply. It [illegible]ds also, from some earlier observations of Rybar [illegible]ik. Zeit.*, 12, 889, 1911) on the related triplet [illegible]rum of lanthanum, that terms with ordinary [illegible]olution and terms with unusual resolution are both [illegible]nt.

[illegible]cording to Landé (*Zeit. f. Phys.*, 17, 292, 1923) [illegible]rdinary g-formula is only valid if in the atomic [illegible]t—that is, the atom without the emitting electron—[illegible]e electrons of the groups with azimuthal quantum [illegible]mbers greater than one form closed configurations [illegible]thout moment of momentum.

[illegible]e neutral scandium atom contains, according to [illegible]h, one single 3_3-electron. The observed separation [illegible]rms show that this single 3_3-electron generally [illegible]ot be present in the atomic rest of the excited [illegible]calium atom, for it cannot be arranged in a closed [illegible]nfiguration. Therefore, it must be the emitting [illegible]ron. The term-scheme really shows that the [illegible]west energy level is a d-term, and this is also con[illegible]rmed by the absorption experiments of Gieseler and [illegible]rian (*l.c.*). In the ionised scandium atom, there [illegible]n 3_3-electron at all, or it must be also in this case [illegible]e emitting electron. The lowest energy level of [illegible]. is not yet known.

It should be noted, however, that the facts obtained [illegible]t the spectra of vanadium and titanium (Gieseler [illegible]cGrotrian, *l.c.*) show that the term-type deter[illegible]ined by means of the term structure and the [illegible]agnetic resolution is not always (perhaps through [illegible]e simultaneous action of different outer electrons) [illegible]one we expect according to the known atomic [illegible]ructure. It may be possible that something of this [illegible]n also happens here.

S. GOUDSMIT.
P. ZEEMAN.

[illegible]msterdam, August 20.

Congenital Eye Anomalies in Albino Mice.

[illegible]ll papers published in the *Journal of Experimental Zoology* (vol. xxvi., 1918, p. 65, and xxxi., 1920, p. 171) [illegible]uyer and Smith have given an account of the trans[illegible]ission, through successive generations, of eye defects [illegible]ich occurred in the offspring of rabbits and mice [illegible]jected, while pregnant, with lens-sensitised fowl [illegible]um. The greater part of the papers concerns [illegible]experiments carried out with albino rabbits, and in [illegible]hat case alone was the question of heredity con[illegible]sidered, but the nature of the defects in both cases [illegible]appears to have been the same.

[illegible]mong a large number of albino white mice which [illegible]roeing bred in this Laboratory, a few have appeared [illegible]recently with abnormal eyes. These have arisen in [illegible]the course of ordinary breeding. The eyes follow in [illegible]appearance the description given by Guyer and Smith; [illegible]they are sometimes reduced in size, and one or both [illegible]eyes are opaque, so that they are of a colourless, [illegible]milky hue instead of the normal red of the albino. [illegible]So far the abnormality has been noticed in about [illegible]4 per cent. of the mice that have been dealt with, [illegible]and while it is at present too early to assert that the [illegible]defect is definitely hereditary, the evidence available [illegible]suggests that this is so.

I should be very interested to hear whether any [illegible]others who have been breeding mice have observed this same abnormality. Guyer and Smith could obtain no information from breeders of similar defects arising naturally in *rabbits*, and concluded that "rabbits are stable forms wholly unlikely to develop eye defects unless, as in our work, these have been deliberately induced by the experimenter." It would appear that as regards albino mice, outwardly similar defects may arise without being deliberately induced, which seems to be a fact of some importance having regard to the bearing of Guyer and Smith's experiments on the problem of the inheritance of acquired characters.

EGON S. PEARSON.

Biometric Laboratory,
University College,
London.

The Stark Effect on Fundamental (Bergman) Series.

ACCORDING to the Bohr theory, we should expect that the Stark effect would be strong in the fundamental (Bergman) series. So far as I am aware, the experimental evidence has not been brought forward, as the lines belonging to this series usually appear in the infra-red region. In a paper published by Saunders (*Astrophys. Jour.*, 52, p. 265, 1920) a certain number of calcium lines in the visible and ultra-violet region are ascribed to the fundamental series.

On referring to my previous work with Mr. N. Kokubu (Mem. Coll. of Sci., Kyoto, 3, p. 173, 1918), I find that many of these fundamental series lines are shifted toward the red by an electric field, as shown in the following table.

	Fundamental triplets $(1d)-(mf)$.				Fundamental Singlets $(1D)-(mF)$.		
m	λ in A	Shifts (for E = 68 kilovolt/cm.)		m	λ in A	Shifts (for E = 68 kilovolt/cm.)	
1	4586·1 81·7 78·8	Not measured		1	4878·3	Not measured	
		p-component	s-component			p-component	s-component
2	4098·8	2·7 A	1·2 A	2	4355·4	4·3 A	2·8 A
	95·3	2·3 A	1·5 A				
	92·9	2·2 A	1·4 A				

On meeting Prof. Saunders at Toronto during the sessions of the British Association, he suggested that this fact might be worthy of mention.

T. TAKAMINE.

Photographs of Lightning.

I AM at present engaged in investigating the forms assumed by lightning flashes in different circumstances and for this purpose require to examine as many photographs of lightning as possible. May I appeal to readers of NATURE who have such photographs to be good enough to give me an opportunity of inspecting them? It is not necessary that the photographs should be technically good; any photographs showing the form of the flash will be valuable. I should like especially to see photographs showing flashes from the tops and sides of clouds.

All photographs will be returned, if required, as soon as they have been examined.

G. C. SIMPSON.

Meteorological Office, Air Ministry,
Adastral House, Kingsway,
London, W.C.2,
September 10.

Present-day Problems in Crop Production.[1]

By Sir E. JOHN RUSSELL, F.R.S.

COMPLEXITY OF THE PROBLEM.

THE agricultural investigator is confronted with three closely interlocking agencies—the plant, the climate, and the soil—each of which is variable within certain limits, and each playing a large part in the crop production which it is his business to study.

Confronted with a problem of this degree of complexity there are two methods of procedure: the empirical method of field observations and experiments, in which there is no pretence of great refinement and no expectation that the same result will ever be obtained twice, it being sufficient if over an average of numerous trials a result is obtained more often than would be expected from the laws of chance; and the scientific method, in which the factors are carefully analysed and their effects studied quantitatively; a synthesis is then attempted, and efforts are made to reconstruct the whole chain of processes and results. The scientific method is, of course, the one to which we are naturally attracted. But common truthfulness compels one to admit that up to the present the greatest advances in the actual production of crops have been effected by the empirical method, and not infrequently by men who are really artists rather than men of science, in that they are guided by some intuitive process which they cannot explain, and that they have the vision of the result before they obtain it, which the scientific man commonly has not.

The best hope for the future lies in the combination of the empirical and the scientific methods. This is steadily being accomplished by the recent strong infusion of science into the art of field experimentation, which has much enhanced the value of the field work and the trustworthiness of its results. Modern methods of replication, such as have been worked out at Rothamsted, and in the United States by Harris of the Carnegie Trust (Cold Spring Harbor), Kiesselbach in Nebraska, Myers and Love of Cornell, and others, constitute a marked improvement in plot technique. The figures themselves, besides being more accurate, can be made to yield more information than was formerly the case.

Great advances have been made in the methods of analysing the results. The figures are never the same in any two seasons, since the climatic conditions profoundly affect the yields. A few men, like J. H. Gilbert, have the faculty of extracting a great deal of information from a vast table of figures, but in the main even the trained scientific worker can make very little of them. The reason is that he has been brought up to deal with cases where only one factor is varying, while the growth of plants involves the interaction of three variable factors: the plant, the soil, and the climate. It is impossible to apply in the field the ordinary methods of the scientific investigator where single factors alone are studied; very different methods are needed, adapted to the case where several factors vary simultaneously.

Fortunately for agricultural science, statisticians have in recent years worked out methods of this kind, and these are being modified and developed by R. A. Fish and Miss Mackenzie for application to the Rothamst field data. It so happens that this material is ve suitable for the purpose, since a large number of t field experiments have been repeated every year f seventy or eighty years on the same crop and on t same piece of land, using the same methods; t field workers also remain the same for many years, t changes being rare and without break in continuit Although the statistical investigation is only recent begun, mathematical expression has already been giv to the relationship between rainfall and yield of whe and barley under different fertiliser treatments, a precision has been given to some of the ideas that ha hitherto been only general impressions. If on average of years a farmer is liable to a certain distrib tion of rainfall, it is becoming possible to advise as fertiliser treatment which enables the plant to ma the best of this rainfall.

ALTERATIONS IN THE PLANT.

It is a commonplace among farmers that certa soil conditions influence not only the yield but also t quality of crops. The leaf and root are more eas affected than the seed. The case of mangolds has be investigated at Rothamsted; the sugar content of t root, an important factor in determining feeding val was increased by increasing the supply of potassium the crop. Middleton at Cockle Park showed that gr increased in feeding value—quite apart from any incre in quantity—when treated with phosphates. Potat are considerably influenced by manuring; increasi the supply of potassium influences the composition the tubers and also that much more impalpable qual —the cook's estimate of the value of the potat while we have found at Rothamsted that a high-cl cook discriminated between potatoes fertilised w sulphate of potash and those fertilised with muriate potash, giving preference to the former.

Grain is more difficult to alter by changes in vironmental conditions; indeed, it appears that t plant tends to produce seed of substantially the sa composition whatever its treatment—with the i portant exception of variation in moisture supply. Shutt has explored the possibilities of altering t character of the wheat grain by varying the conditions, and finds that increases in soil moist decrease the nitrogen in the grain. Similar resu have been obtained in the United States.

On the other hand, in England the reverse seems hold, at any rate for barley. This crop is being fu investigated at the present time under the resea scheme of the Institute of Brewing, because of importance in the preparation of what is still Britai national beverage. Increased moisture supply creases the percentage of nitrogen in the grain, and also does increased nitrogen supply, though to a mu less extent; on the other hand, both potassic a phosphatic fertilisers may decrease the percentage nitrogen, though they do not always do so; the la regulating their action are unknown to us.

[1] From the presidential address delivered to Section M (Agriculture) of the British Association, Toronto, August 11.

The practical importance of these problems of regulating the composition of the plant lies in the fact that the farmer can control his fertiliser supply, and to some extent his moisture supply, so that it lies within his power to effect some change should he wish to do so.

In agricultural science one sometimes thinks only of the crop and the factors that affect its growth. But in agricultural practice there is often another partner in the concern: a pest or parasite causing disease. The amount of damage done by pests and diseases to agricultural crops is astounding; in Britain it is probably at least 10 per cent. of the total value of the crops and the loss is probably some 12,000,000*l.* sterling per annum; in some countries it is considerably more. Indeed, the number of insect pests and of harmful fungi and bacteria that skilled entomologists and mycologists have found in our fields might almost lead us to despair of ever raising a single crop, but fortunately the young plant, like the human child, grows up in spite of the vast number of possible deaths. The saving fact seems to be that the pest does harm only when three sets of conditions happen to occur together: the pest must be present in the attacking state; the plant must be in a sufficiently receptive state; and the conditions must be favourable to the development of the pest. It is because this favourable conjunction of conditions comes but rarely that crops manage to survive; and this gives us the key to control if only we knew how to use it. Complete control of any of these three conditions would end all plant diseases. Unfortunately, control is never complete even in glasshouse culture, still less out of doors. But even partial control would be very helpful. All these pests go through life cycles, which are being studied in great detail all over the world, and especially in the United States. Somewhere there occurs a stage which is weaker or more easily controlled than others, and the pest would become harmless if the chain could be broken here or if the cycle could be sufficiently retarded to give the plant a chance of passing the susceptible stage before it is attacked.

The plants themselves, as we have just seen, are in some degree under control, and if they could be pushed through the susceptible stages before the pest was ready, they would escape attack. Barley in England is sometimes considerably injured by the gout fly (*Chlorops tæniopus*). The larvæ emerge in spring from the eggs laid on the leaves and invariably crawl downwards, entering the young ear if, as usually happens, it still remains ensheathed in leaves. J. G. H. Frew, at Rothamsted, has shown that early sowing and suitable manuring cause the ear to grow quickly above the track of the larvæ, and thus to escape injury. E. A. Andrews, in India, has found that tea bushes well supplied with potassic fertiliser escape attack from the mosquito bug (Helopeltis) for the rest of the season, apparently because bushes so treated become unsuitable as food to the pest. Further, the conditions are alterable. H. H. King, in the Sudan, has effected some degree of control of the cotton thrips (*Heliothrips indicus*) by giving the plant protection against the drying north wind and so maintaining a rather more humid atmosphere—a condition in which the plant flourishes more than the pest. Tomatoes in England suffered greatly from Verticillium wilt until it was found that a small alteration of temperature threw the attack out of joint. They are also much affected by stripe disease (*B. lathyri*), but they become more resistant when the supply of potash is increased relative to the nitrogen. It has recently been maintained, though the proof is not yet sufficient, that an altered method of cultivating wheat in England will afford a good protection against bunt. These cultural methods of dealing with plant diseases and pests offer great possibilities, and a close study jointly by plant physiologists and pathologists of the responses of the plant to its surroundings, and the relationships between the physiological conditions of the plant and the attacks of its various parasites, would undoubtedly yield results of great value for the control of plant diseases. Again, however, the plant breeder can save a world of trouble by producing a variety resistant to the disease; or there may fortunately be found an immune plant from which stocks can be had, as in the case of the potatoes found by Mr. Gough to be immune to the terrible wart disease.

Control of Environmental Factors.

It thus appears that, if only plant breeders and plant physiologists could learn to alter existing plants or to build up new plants in such a way that they should be well adapted to existing soil and climate conditions, and not adapted to receive disease organisms at the time the organisms are ready to come—if only they could do this, all agricultural land would become fertile and plant diseases and pests would become ineffective: at any rate until the pests adapted themselves to the new plants. Although no one can set limits to the possibilities of plant breeding and plant physiology, we cannot assume that we are anywhere near this desirable achievement or that we are likely to be in our time.

There will always remain the necessity for altering the environmental conditions to bring them closer to the optimum conditions for the growth of the plant. No attempt is yet made in the field to control two of the most important of the factors: the light and the temperature, though it is being tried experimentally. There is a great field for future workers here; at present plants utilise only a fraction of the radiant energy they receive. At Rothamsted attempts have been made by F. G. Gregory to measure this fraction; the difficulties are considerable, but the evidence shows that our most efficient plants lag far behind our worst motor-cars when regarded as energy transformers for human purposes. One hundred years ago the efficiency of an engine as a transformer of energy was about 2 per cent.; now, as a result of scientific developments, it is more than 30 per cent. To-day the efficiency of the best field crops in England as transformers of the sun's energy is about 1 per cent.:[2] can we hope for a similar development in the next hundred years? If such an increase could be obtained an ordinary crop of wheat would be about 400 bushels per acre, and farmers would feel sorry for themselves if they obtained only 200 bushels. But we are only at the beginning of the subject. Increases in plant growth amounting to some

[2] The remaining energy being largely used up in transpiration. This figure refers to the total radiation received by the leaf, and not to the fraction received by the chloroplast surface. For this latter the value is much higher.

20 or 25 per cent. have been obtained by V. H. Blackman in England under the influence of the high-tension electric discharge, which presumably acts by increasing in some way the efficiency of the plant as an energy transformer. Possibly other ways could be found. It needs only a small change in efficiency to produce a large increase in yield. Much could be learned from a study of the mass of data which could be accumulated if agricultural investigators would express their results in energy units as well as in crop yields as at present.

Interesting results may be expected from the attempts now being made in glasshouse culture both in Germany and at Cheshunt to increase the rate of plant growth by increasing the concentration of the carbon dioxide in the atmosphere.

Control of the Soil Factors.

The soil factors lend themselves more readily to control and much has been already achieved. Water supply was one of the first to be dealt with. Civilisation arose in the dry regions of the earth, and so far back as 5000 years ago, irrigation was so advanced as a practical method that it came into the ordinances drawn up by the great Babylonian king Hammurabi. The chief problems at the present time are to discover effective means of economising water and to ascertain, and if possible control, the relationships between the soil, the water, and the dissolved substances in the water.

Inseparably bound up with water supply are the questions of cultivation and of drainage, which affect not only the water but the air supply to the roots. The former subject is now attracting considerable attention: the great need is to discover means for expressing cultivation in exact physical and engineering units. The measurements of Keen and Haines at Rothamsted, and the chemical work of A. F. Joseph, N. Comber, and others on clay, and of Odén, Page, and others on humus, indicate the possibility of finding exact expressions and of effecting co-operation with the workers in the new fields of agricultural engineering.

Another soil factor which readily lends itself to some degree of control is the amount of plant nutrients present. The possibility of increasing this by means of manure has been so frequently explored in field trials that it has sometimes been regarded as almost a completed story; indeed, Rothamsted tradition affirms that Lawes himself once gave orders to have the Broadbalk field experiments discontinued because they had nothing further to tell; it was only the earnest persuasion of Gilbert that caused him to countermand the order. So far from the subject being exhausted, it still bristles with problems. The new nitrogenous fertilisers, resulting from War-time activities in nitrogen fixation; the need for reducing the cost of superphosphate; the change in character of basic slag; and the Alsatian development in potash production, are producing changes in the fertiliser industry the full effects of which are not easy to foresee. Economic pressure is driving the farmer to derive the maximum benefit from his expenditure on fertilisers, lime, farmyard manure, and other ameliorating agents, and is compelling a more careful study of possibilities hitherto disregarded, such as the use of magnesium salts, silicates, and sulphur as fertilisers, and, above all, a much more precise diagnosis of soil deficiencies than was thought necessary in pre-War days.

There are, however, more fundamental problems awaiting solution. It is by no means certain that we know even yet all the plant nutrients. The list compiled by Sachs many years ago includes all needed in relatively large amounts, but Gabriel Bertrand has shown that it is not complete and that certain substances—he studied especially manganese—are essential, although only in very small amounts. Miss Katherine Warington, working with Dr. Brenchley at Rothamsted, has shown that leguminous plants fail to develop in the so-called complete culture solution unless a trace of boric acid is added. Mazé has indicated other elements needed in small amounts.

Another problem needing elucidation is the relationship between the quantity of nutrients supplied and the amount of dry matter produced. Is dry matter production simply proportional to nutrient supply, as Liebig argued, with the tailing off beyond a certain point, as demonstrated by Lawes and Gilbert, or is it always less than this, as indicated by Mitscherlich's logarithmic curve; or is the relationship expressed by one of the more complex sigmoid curves as there is some reason to suppose? We do not know; and the problem is by no means simple, yet it governs the "diminishing returns" about which farmers now hear so much.

Again, very little is known of the relationship between nutrition and the period of growth of a plant. One and the same quantity of a nitrogenous fertiliser, for example, may have very different effects on the plant according as it is given early or late in life; not only is there a difference in quantity of growth, but also in the character of the growth. Late dressings cause the characteristic dark-green colour to appear late in the season, and thus affect the liability to fungoid diseases; they increase the percentage of nitrogen in the grain and they may give larger increases of crop than early dressings.

Investigations are needed to find the best methods of increasing the supply of organic matter in the soil and its value for the different crops in the rotation.

All these problems will sooner or later find some solution. But there remains a greater problem of more importance than any of them: the linking-up of plant nutrition studies with those of the soil solution. As our cousins in the United States were the first to emphasise, the fundamental agent in the nutrition of the plant is the soil solution, and they have made a remarkable series of investigations into what appeared at one time a hopeless proposition—the physico-chemical interactions between the soil and the soil water. A great advance in crop production may be expected when the soil chemists have discovered the laws governing the soil solution, when the plant physiologists can give definite expression to the plant's response to nutrients, and when some one is able to put these results together and show how to alter the soil solution so that it may produce the maximum effect on the plant at the particular time. The new soil chemistry will yet have its triumphs.

The Soil Micro-organisms.

It is now more than forty years since the discovery of the great importance of micro-organisms in determining soil fertility. Practical applications necessarily lag far behind; but already three have been made each of which opens out great possibilities for the future. The long-standing problem of inoculation of leguminous crops with their appropriate organisms has already been solved in one or two of its simple cases, chiefly lucerne in new land, and the new process has helped in the remarkable extension of the lucerne crop in the United States and in Denmark. We believe at Rothamsted that the more difficult English problem is now solved also. Interesting possibilities are opened up by the observation that a preliminary crop of Bokhara clover seems to facilitate the growth of the lucerne.

The organisms effecting decomposition are now coming under control, and are being made to convert straw into farmyard manure (or a material very much like it) without the use of a single farm animal. The process was worked out at Rothamsted, and is being developed by the Adco Syndicate, which is now operating it on a large scale and is already converting some thousands of tons of straw annually into good manure.

The third direction in which control of the soil organisms is being attempted is by partial sterilisation. This process is much used in the glasshouse industry in England, and it has led to considerable increases in crop yields. The older method was to use heat as the partial sterilising agent, and this still remains the most effective, but owing to its costliness, efforts have been made to replace it by chemicals. Considerable success has been attained; we have now found a number of substances which seem promising. Some of these are by-products of coal industries; others, such as chlor- and nitro-derivatives of benzene or cresol, are producible as crude intermediates in the dye industry.

The Need for Fuller Co-operation.

Looking back over the list of problems it will be seen that they are all too complex to be completely solved by any single worker. Problems of crop production need the co-operation of agriculturists, plant physiologists, soil investigators, and statisticians. Even plant breeding necessitates the help of a physiologist who can specify just what the breeder should aim at producing. This gives the key-note to the period of agricultural science on which we have now entered—it is becoming more and more a period of co-operation between men viewing the problem from different points of view. Good individual work will of course always continue to be done, but the future will undoubtedly see a great expansion of team work such as we know from our experience at Rothamsted is capable of giving admirable results in agricultural science.

With fuller co-operation both of men and of institutions we could do much to overcome the present difficulty in regard to utilising the information we already possess. In the last thirty years an immense stock of knowledge has been obtained as to soils and crops. It is stored in great numbers of volumes which line the shelves of our libraries, and there much of it rests undisturbed in dignified oblivion. In the main it consists of single threads followed out more or less carefully; only rarely does some more gifted worker show something of the great pattern which the threads compose. But even the most gifted can see but little of the design; the best hope of seeing more is to induce people to work in groups of two or three, each trained in a different school and therefore looking at the problem from a different point; each seeing something hidden from the rest. Unlike art, science lends itself to this kind of team work; art is purely an individual interpretation of Nature while science aims at a faithful description of Nature, all humanistic interpretation being eliminated. There is certainly sufficient good will among the leaders of agricultural science to justify the hope of co-operation; there are probably in existence foundations which would furnish the financial aid.

This leads to my last point. What is the purpose of it all? Team work, co-operation, the great expenditure of time and money now being incurred in agricultural science and experiment—these are justified only if the end is worthy of the effort. The nineteenth century took the view that agricultural science was justified only in so far as it was useful. That view we now believe to be too narrow. The practical purpose is of course essential; the station must help the farmer in his daily difficulties—which again necessitates co-operation, this time between the practical grower and the scientific worker. But history has shown that institutions and investigators that tie themselves down to purely practical problems do not get very far; all experience proves that the safest way of making advances, even for purely practical purposes, is to leave the investigator unfettered. Our declared aim at Rothamsted is "to discover the principles underlying the great facts of agriculture and to put the knowledge thus gained into a form in which it can be used by teachers, experts, and farmers for the upraising of country life and the improvement of the standard of farming."

This wider purpose gives the investigator full latitude, and it justifies an investigation whether the results will be immediately useful or not—so long as they are trustworthy. For the upraising of country life necessitates a higher standard of education for the countryman; and education based on the wonderful book of Nature which lies open for all to read if they but could. How many farmers know anything about the remarkable structure of the soil they till, of its fascinating history, of the teeming population of living organisms that dwell in its dark recesses; of the wonderful wheel of life in which the plant takes up simple substances and in some mysterious way fashions them into foods for men and animals and packs them with energy drawn out of the sunlight—energy which enables us to move and work, to drive engines, motor-cars, and all the other complex agencies of modern civilisation? No one knows much of these things; but if we knew more, and could tell it as it deserves to be told, we should have a story that would make the wildest romance of human imagination seem dull by comparison and would dispel for ever the illusion that the country is a dull place to live in. Agricultural science must be judged not only by its material achievements, but also by its success in revealing to the countryman something of the wonder and the mystery of the great open spaces in which he dwells.

Recent Work at Stonehenge.

By Lieut.-Col. WILLIAM HAWLEY.

CONSIDERABLE progress has been made during the last two years in the work of excavation which is being carried out at the site of Stonehenge, and although nothing giving any clue to the age and purpose of the monument has yet been discovered, many places in the area surrounding it have yielded matter of much interest and importance.

In order to find out the conditions of the Avenue and its relation to the place, an excavation of the ditch around the circular rampart was begun about 40 feet from where it would approach the south bank of the Avenue. The ditch was 6 feet deep where digging began, suddenly rising soon afterwards to a level 3 feet higher, but gradually returning to nearly the former depth as it went onwards. When the line of the Avenue bank was reached, there was no trace of it meeting the ditch, which passed on for about 25 feet beyond the spot and ended against a very upright bank of solid chalk about 5 feet high, widening and taking a roughly circular form with a flat bottom. An excavation, in the line of the ditch, made about 50 feet beyond this obstruction revealed a similar solid side. The intervening portion, which was 40 feet wide, proved to be a causeway of natural chalk which crossed the ditch and afforded an entrance to the circular enclosure. The ending of the ditch on the west was roughly circular like that on the east side, but here it formed a large wide pit 7½ feet deep communicating with another beyond it through a narrow opening. Both bore traces of fires at the bottom, and scattered around them were horn picks, bones of animals, and quantities of flint flakes.

The surface of the causeway was very remarkable as it was studded with 58 holes, more or less in regular lines, occupying the entire length and width of it. These were probably of the same age as the ditch, and with it seem to have been for defence and resisting combined attack, pointing to the place in its early history being one of defence.

In the entrance and in line with the rampart crest a large stone hole was found close to another previously excavated, the latter being the one the "Slaughter" stone is thought to have stood in.

Excavation afterwards included the portion of the Avenue between the entrance and the fence at the high road. The small side banks and ditches of it begin 10 feet from the main ditch, showing that the Avenue was independent of it and probably of later construction. Formerly it was believed that the Avenue entered Stonehenge, but it is now seen that the actual entrance was over the causeway, mentioned above, and only about half as wide. The Avenue is 70 feet wide where it begins, but the ditches are irregular in their alignment, carelessly dug, and of a variable depth of about 3 feet.

The ditches have a layer of silt upon the bottom, reaching half-way up, which contains nothing of the Stonehenge period, but the stratum over it does, so it might be inferred from this that the Avenue preceded Stonehenge by a considerable interval. Evidence of the Stonehenge period is gained from a stratum which varies from an inch or two to 15 inches in depth and is distributed with very fair evenness over the whol surface of the place. It contains the mason's chip and things that belong to and after that period alon and therefore is a most useful guide for determinin periods which precede and those which follow after th making of the monument, helping also to show that i is of Neolithic age. It has been necessary to mak this digression in order that the context may be mor clearly understood.

There were two large holes found near the Helestone and there can be little doubt that they once hel stones, and their filling of loose chalk was that whic fell back when they were extracted. Over one of them there was a dump of nearly four thousand sarse chippings and sandy debris, showing that a stone ha been dressed on the spot, and no doubt taken from th hole and, after preparation, used for the monument It seems from this that there may have been a certai number of rough sarsens already *in situ* here befor Stonehenge was built. Each of the stones was 40 fee from the Helestone and suggest that a little grou might have stood there independently of anything tha might have been standing within the circle at the time

A trench 4 feet wide was found around the Helestone but only a part was excavated, as the remainder i covered by the high road. Like the small ditches, i had been half filled with silt, which had chips in th filling over it, but not in it, thus showing an earlie origin than Stonehenge.

Three large post holes occurred westward from the Helestone, with distances equally divided. They resembled those on the causeway and were certainly of early date, as the Avenue bank on the west covered two of them. The remainder of the Avenue was quite barren of anything of interest and had been much eroded by a medieval coach road and country traffic.

Excavation was afterwards transferred to the interior of the circular enclosure, and a systematic search began of the land within by cutting trenches in close succession over it from the rampart nearly up to the standing stones. Last year 107 trenches were opened and the N.E. quadrant accounted for, and this year it is hoped to complete the S.E. quadrant. The trenches were mostly over shallow ground and, on the whole, not very productive, but some of them certainly afforded places giving much information and interest.

The first line of trenches was directed towards the entrance at the standing stones, and, after proceeding a little way, holes were come to of a sharply cut, rectangular, oblong form, measuring about 5 feet long by 3 feet wide at the top, tapering in a wedge shape to a narrow bottom. These were found to extend in a regular succession in two rows around the outer circle, the holes of each new circle being exactly opposite standing stones. It was afterwards ascertained by sounding that similar cavities exist around the present outer circle, indicating that there were once two extra circles to the monument. For the sake of reference they have been called Y and Z circles. The first holes of the former began at 38 feet from the standing stones, and the latter 10 feet distant. Their side intervals are

rular but they are not concentric with the standing
le nor in relation to themselves. The distance from
outer circle gradually diminishes from where they
in at the entrance until No. 8 is reached, after
ich they take up the original distance; this applies
both circles. Some confusion was noted where the
egularities terminated; No. 7 hole had been only
rtly dug, and Z8 was found not to exist.

It can be clearly proved that these holes were made
the Stonehenge period, because the mason's chips
re present in the filling and even upon the bottom.
e first four holes excavated occur in the fairway
m the entrance, and it may be safely said that they
ver held stones. Although dug for the purpose,
nsideration afterwards led them to leave the holes
npty, as the stones would have been inconvenient in
e fairway. Their sharpness and undisturbed con-
ion showed there had been no insertion and extrac-
n of stones; moreover, one of them contained five
g antlers and another a single antler, showing
sence of stones. The other holes showed disturb-
ces caused by extracting stones. Soil had fallen
ck, partly filling the holes, and over it was a more
cent stratum bearing objects from the time of
traction to the present day. Romano-British
jects were found in the upper stratum, and in one
le, about 18 to 20 inches from the top, there was
rty soil mixed with wood ashes and some natural
nts arranged apparently as a temporary hearth, and
the same level were 42 pieces of a Romano-British
t. A little below this level were three pieces of fine,
itty pottery belonging to the "La Tene" period.
his gives the impression that the stone was extracted
that time, and that spoliation on the site might
ve begun quite an early date.

Where the irregularity occurred at No. 8, a con-
derable area was opened out to try to discover a
ason for it, but with not much success. A great
any post holes were met with, and, since then, a still
reater number have been found extending from this
ot towards the rampart, some of them taking the
rm of parallel lines; these are now in course of
vestigation. They are evidently of quite early date,
s the Stonehenge stratum passes over them and they
ntain nothing of that period. Eleven of them, about
6 feet apart, formed a long row, the last two holes at one end having been united by digging to form a grave at a time when posts no longer stood there, the holes and loose matter affording less trouble in digging one. A skeleton found in it proved to be that of a person belonging to a long-headed race existing shortly before the Roman occupation. Owing to insufficient length and capacity of the grave (barely 3 feet deep) the remains were much crushed, but have nevertheless been reconstructed.

Remains of the Bronze age do not occur until after the erection of Stonehenge and are found in the upper stratum consisting chiefly of foot-worn fragments of pottery. With a cremation of that period there was found a beautifully ground and polished mace head of the "cushion" type. The stone is hornblendic gneiss and probably came from Brittany. Eight other specimens are known to exist of that type, now in collections, five of them coming from Scotland and three from the Thames and its neighbourhood, and they are regarded as ceremonial maces of that period. With another cremation a very fine bone pin 7 inches long was found. It had been burnt with the body and was much twisted by heat and broken in three places, but was easily mended. The cremated remains are usually found but a short distance below ground, most of them actually without cists in the loose chalk rubble at the foot of the rampart; sometimes the remains are found clinging to a turf when it is cut and turned over. This shows that the rampart conditions cannot have been very different then from what we see them now. The impression created during the continuance of excavation here makes one aware that a long succession of events is being dealt with which have covered a vast number of years. The silting of the main ditch alone is a proof of this. This process must have taken a very long time, for sometimes there are 6 feet of it and not a vestige of the Stonehenge era occurs in it, and is only met with as a narrow stratum below the turf and abruptly divided from it. Unfortunately, none of these matters have as yet given any information as to the date of the monument, but there is yet a great deal of ground to be opened, and by more time and diligent search it is hoped eventually to arrive at some clear conclusions.

Circumnavigation of the Earth by Aeroplane.

ON April 6, four U.S.A. aeroplanes left Seattle on an air voyage of circumnavigation of the world. Five months later, on September 6, two out of the four arrived at Boston. Flying took place on 48 days out of 153 days thus consumed. The actual flying hours were 288; the distance covered was 21,500 miles. About every third day on the average was therefore a flying day of 6 hours flying at 75 miles per hour, giving a flying day's run of 450 miles.

The flight falls naturally into four stages, floats being fitted for stages 1 and 3, wheels for 2 and 4. New engines were fitted at the start, and in Japan, at Calcutta, and at Hull. New wings were fitted at Calcutta, and numerous subsidiary repairs and replacements were carried out. Cruisers, supply ships, and flotillas of destroyers were employed in the improvised organisation along the sea routes. Existing permanent organisations were available along the land routes.

In stage 1 the route runs along the Pacific Coast of Canada and Alaska, and crosses the northern entrance of the Pacific Ocean by the Aleutian Islands; thence it runs by Kamchatka and Japan round the Chinese and Burmese coast to Calcutta. The Aleutian Islands, in which aeroplane No. 1 fell out, are subject to fogs, squalls and blizzards, the Chinese seas to typhoons, and the southern arc, Saigon—Rangoon, to tropical heats. There is no permanent airway organisation in the first part of this stage, and in the second part the Japanese, French and British organisations are not continuous. In this stage as a whole, flying took place only on 22 days out of 82, 11,000 miles being covered in 158 flying hours.

At Calcutta 4 days were spent in fitting new engines, new wings, and wheels for the overland stage Calcutta—

London. Leaving Calcutta on July 1 and arriving at Hull on July 17, the aeroplanes flew on 15 days out of 17, covering a distance of 6500 miles in 74 flying hours. The advantage of a permanent ground organisation is evident, and to this is added the inherent advantage of wheels over floats in both weight and air resistance.

At Hull 11 days were spent in overhauling the aeroplanes and in fitting new engines, and floats for the passage of the northern entrance of the Atlantic by way of the Orkneys, Faroë Islands, Iceland, Greenland and Labrador. Leaving Hull on July 30, and arriving at Boston on September 6, the aeroplanes flew on 11 days out of 39, 4000 miles being covered in 56 flying hours. Aeroplane No. 3 fell out between the Orkneys and Iceland. The remaining stage is from Boston via New York to Washington, thence due west to Salt Lake City, and so back to Seattle. Fitted with wheels, and using a homogeneous national air organisation, there is high probability that the two surviving aeroplanes will complete expeditiously the circumnavigation of the earth by air except in so far as they are detained by the hospitality of their countrymen at the landing places.

In drawing technical conclusions from the flight, no account can be taken of the great personal effort of the pilots and mechanics in thus facing successfully every sort of condition along 24,000 miles of route, unknown to them. The quasi-sporting condition that the same aeroplane bodies should circle the earth albeit with new engines, wings and other parts is also irrelevant. In a strictly utilitarian organisation fresh machines and pilots familiar with the route would be available for each 5-hour stage, and two such stages a day would be feasible. When it is found possible to maintain permanent airway organisation along such regions as the northern entrances of the Atlantic and Pacific Oceans, it may become possible, flying 10 hours a day at 100 miles per hour, to circumnavigate the world by air in about 24 days as a matter of routine travelling.

Obituary.

Mr. Hartley Lupton.

BY the death on September 6 of Mr. Hartley Lupton, at the early age of thirty-two years, physiology has lost a research worker of great industry and promise, his pupils a teacher who won their respect by his care and keenness and their affection by his simplicity and kindness, his friends at Manchester and at University College, London, a generous and devoted colleague. For generosity, simplicity, and devotion were the keynotes of Lupton's life. Stricken with a fatal illness in June, he spoke continually of returning to his beloved apparatus in a few weeks. Only a month before his death, at a time of great discomfort and distress, he read with appreciation and delight the manuscripts of three papers shortly to appear in the Proceedings of the Royal Society, describing the results of three years of devoted work. Rarely, until his last illness had completely incapacitated him, was he absent from the laboratory: he arrived first in the morning, he left last at night; he was always ready for any new experiment, any new enterprise, any extra work.

Lupton had an extraordinary capacity for friendship with young men, a capacity which served him well as a tutor at Dalton Hall, Manchester, and later in his physiological research work, where he continually needed "subjects" for his experiments. All who knew him will recall the pleasant and humorous picture of Lupton engaged in some experiment on severe muscular work, either on himself or some friend whom he had induced to take (at any rate temporarily) a sufficient interest in physiology to act as the subject of his—often rather strenuous—experiments. His own personal devotion can be gauged from the frequent entry "Subject, H. L. postabsorptive" in his records.

Lupton obtained a first-class honours degree in physics at the University of Manchester: the outlook of the physicist remained with him in his later work, and led to the scrupulous accuracy which is seen in all the records of his observations. His first independent scientific task was the routine work with radium at the Manchester Royal Infirmary. His experience there led his questioning mind to ask for the reason why radioactive bodies should have the effect they do on living tissues: the next step was to decide to take a medical degree, and it was as a student of physiology that the present writer first made his acquaintance. His teachers soon realised that Lupton was a person of rather singular interests and capacity, and an early opportunity occurred of starting him on physiological research. Working for the Medical Research Council, he took up the study of muscular exercise in man, based on the results of recent investigations of the isolated muscle. The subject proved fertile beyond expectation, and the results of it are contained in several papers published in the *Quarterly Journal of Medicine*, the *Journal of Physiology*, and the Proceedings of the Royal Society. When he began this work, three years ago, little was known of the connexion between the physiology of the muscle and that of human muscular exercise. Three years of continual labour—years probably the happiest of his life, for he was never so happy as when "going all out"—have discovered and explored a new subject, the important one of the recovery process after muscular effort in man. To the physiological world the subject will remain, one may hope, associated with his name: to his colleagues it will always recall the unceasing devotion and the simple kindness of their friend. A. V. H.

Prof. B. I. Slovzov, professor of biochemistry in the University of Saratov, and later in the Medical School for Women, Petrograd, whose death is announced, was a pupil of A. Kossel and A. Danilevsky and is known mainly for his contributions to the study of tissue enzymes. Another Russian man of science who has died recently is Prof. N. P. Kravkov, professor of pharmacology in the Medical Academy, Petrograd. Prof. Kravkov was a pupil of Schmiedeberg, and his chief work was performed on isolated organs which he used mainly for investigating the action of drugs upon blood-vessels. His method of the isolated rabbit's ears for testing vasoconstrictor and vasodilator substances is known universally and used in every pharmacological laboratory. Lately he contributed interesting observations upon the coronaries of the human heart and the isolated human fingers. He had been interested in the past few years in the action of drugs in highly diluted solutions.

Current Topics and Events.

WE are glad to learn that Mr. Jowett, First Commissioner of Works, has now definitely refused to permit the sect of Latter-Day Druids, or "Church of the Universal Bond," to make use of Stonehenge for the burial of the ashes of their dead. In a letter to Lrd Crawford, Mr. Jowett says, "I have decided that under no circumstances can any burials be permitted within the precincts of Stonehenge in the future." When the proposed desecration of the national monument became known, strong protests were raised against it, and in our issue of September 6, p. 364, we expressed the resentment generally felt in regard to the claims and intentions of the sect which contemplated such action. It would probably be difficult to prevent members of the sect from scattering ashes of certain of their dead members within Stonehenge, but we assume that no formal assembly for this purpose will be authorised. In his reply to a question in the House of Commons in July, Mr. Jowett said that no objection would be raised to the use of the national monument for the proposed burial of such ashes, provided that there was "no serious disturbance of the ground," and the sect announced that no such disturbance was intended, as there would be "nothing in the nature of an interment." It is not yet clear whether the sect may hold a service within the precincts of Stonehenge and formally scatter the ashes of their dead upon the ground.

AN interesting event took place at the house of the Royal Photographic Society, 35 Russell Square, on Saturday afternoon, September 13, when a memorial tablet to William Henry Fox Talbot was unveiled in the Library by Dr. G. H. Rodman, a past president of the Society. A distinguished company included Miss M. Talbot and Mrs. Stewart, grand-daughters of the distinguished investigator whose memory was honoured. Dr. Rodman, after referring to the historical collection of experimental apparatus used by Fox Talbot and presented by Miss M. Talbot to the Museum of the Royal Photographic Society, reviewed Talbot's photographic researches, which appear to have been commenced in 1834. In that year, on the lines of Schutze, Scheele, and Wedgwood, Talbot produced sun prints of lace and leaves on paper treated with silver nitrate and sodium chloride; in 1835 he secured an image on moist sensitised paper in the camera obscura on a bright day with an exposure of ten minutes. The results of his researches were communicated in 1839 to the Royal Society in two famous papers on photogenic drawing. In 1840, by the use of paper impregnated with silver iodide and gallo nitrate of silver, Talbot secured results in ten seconds. The process, which he termed the calotype process, was patented in 1841 after a means had been found to obtain positive prints from the negatives. Dr. Rodman paid an eloquent tribute to the value of Fox Talbot's contribution to science through these researches, upon which the modern practice of photography is based. The memorial, by Messrs. George and Fred Hawkings, consists of a finely modelled portrait of Fox Talbot, executed in bronze, with decorative surroundings upon a marble background, and bears the inscription—"William Henry Fox Talbot, 1800–1877. This Memorial was erected by public subscription of photographers, 1922."

THREE years ago, the Notgemeinschaft der Deutschen Wissenschaft was formed for co-ordinating all help received in Germany for the learned staffs of universities, technical high schools, and other institutions. The third report of this society has been issued and can be obtained from the offices situated in the Schloss, the former residence of the Kaiser, Berlin, C2 Schloss, Portal 3. It seems that 1923–4 was a year of very real need indeed; the period lasting until November 1923, when a very adverse rate of exchange existed, making foreign purchases impossible, was followed by a period of great want of money, making not only foreign but also internal purchases difficult. In 1923, the Reichstag made three grants of money, although it was not in a position to pay immediately. The most valuable of these was made in October and consisted of 500,000 gold marks (approx. 27,000*l*.). It was not possible to continue the programme of buying the most important journals published during the War until the fall in the mark had ceased. The sum of 46,000 gold marks (2500*l*.) was expended on the libraries of 23 universities, 11 technical high schools, and 300 larger institutions. Twenty-five copies of the Paris *Comptes rendus* had to supply all these institutions. Foreign periodicals were cut down to one-fortieth of pre-War supply, and journals in covers were circulated for two months at a time to the individual universities. It was only possible to buy sixty foreign books of average value 15 marks, for each institution, but this number was increased by gifts from Switzerland, Sweden, Norway, U.S.A., Spain, and Great Britain. During this period it was possible to publish 117 periodicals and 103 books in all fields of knowledge on the funds of the association. Many German firms helped the funds by providing apparatus for special researches. Hajime Hoshi, of Japan, provides 2000 yen monthly for the period of three years for chemical research. The General Electric Company of America provided 12,500 dollars, to which German electrical firms added 1250 dollars, for electrophysical research under a committee consisting of Planck, Laue, Franck, Haber, Nernst, and Wien. In all faculties it was possible to make grants to 100 people of 25 to 100 dollars for special researches and journeys. It is hoped that the financial situation this next twelve months will be such that Germany will be able to buy foreign periodicals and books and resume the international exchange of academic thought.

THE low temperature carbonisation of coal excites at the present time the widest interest. The intelligent member of the general public hears much of it as a solution of the smoke problem and that of the supply of liquid fuel. The truth is often difficult

to get, especially by those desirous of appraising the validity of inventors' claims. The information conveyed in a circular just issued by the Department of Scientific and Industrial Research will therefore attract widespread interest. The offer is made that the Fuel Research Staff of the Department will undertake to test, without fee, approved plant and processes for low temperature carbonisation, under certain conditions. Application must be made on forms obtainable at the offices of the Department, 16 Old Queen Street, Westminster, S.W.1. The gist of the conditions may be summarised as follows. Applicants are to furnish full information and facilities for prior inspection by officers of the Department to permit of a decision as to the justifiability of a test. If undertaken, the test will be made under the supervision of a member of the Fuel Research Staff. Applicants will have to provide all requisite facilities, including material, staff, labour and measuring instruments, considered necessary. Applicants may be represented during the test, but the decision as to duration and conduct of the test will rest with the officer of the Fuel Research Staff supervising. The Department reserves to itself the right to publish a report on the results of tests made.

NOT the least important of the departmental exhibits in the British Government Pavilion at the British Empire Exhibition, Wembley, is that illustrating the work of the Imperial Institute in promoting the use of little-known or new raw materials of the Empire. The exhibit directs attention to the principal branches of the Institute—the scientific and technical department, the technical information bureau, and the exhibition galleries—and illustrates by series of specimens and publications the nature of the work carried out by the departments and technical committees. A collection of British Empire timbers includes samples of little-known woods recommended for use in Great Britain by the Timbers Committee of the Institute and fully tested in the timber laboratory. The fibre exhibits include samples of cottons from Irak and Tanganyika, and an important exhibit of silk cocoons, reeled and thrown silk and fabrics woven therefrom, illustrates the endeavours of the Institute's Silk Committee to extend the production of raw silk within the British Empire. There is an interesting display of new materials suitable for paper-making, and of papers made from them. The investigations of plantation rubber, carried out in connexion with the Ceylon Rubber Research Scheme, are also illustrated. Other sections relate to the work on oil-seeds, essential oils, tobaccos, resins, tanning materials, and drugs; and there is a collection of economic minerals including tropical African coals; materials for pottery, brick, and cement manufacture, illustrated by specimens of products made from them at the Institute; and radio-active and other minerals. A free pamphlet describing the exhibits and the departments of the Institute has been issued and may be obtained at Wembley, or on application to the Director, Imperial Institute, London, S.W.7.

WE have received from Messrs. Thomas Firth and Sons, Ltd., a statement containing some of the essential features of their exhibit at the Britis Empire Exhibition. A very wide range of produc has been gathered together. Firth's stainless steel now so well known amongst engineers that conside able attention will doubtless be focussed on th branch of their manufactures. A selection of man different types of turbine blading is shown, includir twelve blades removed from a 2000 KW. Westing house turbine (steam pressure 200 lb., superhe 200° F.). Nine of these are of 5 per cent nickel stee the remainder are of Firth's stainless steel. Th actual hours run were 12,809 in six cases and 29,98 in the remainder. All the nickel steel blades sho very marked signs of erosion, being very rough an pitted; the edges also show distinct signs of frayin Those which have given longest service are quit worn out. The stainless steel blades, on the othe hand, are as bright and as unaffected as the day c which they were inserted; the edges retain the initial sharpness and no signs of wear are apparen anywhere. Turbine engineers will doubtless tak note of this remarkable difference in properties. pump rod of similar steel which has been in use i an ammoniacal liquor pump is also shown. The li of carbon steel rods is never more than about si months. The stainless steel rod is worn only abou $\frac{5}{64}$ths of an inch. Moreover the surface is smoot and polished and not badly scored as it is in the cas of carbon steel rods. A rake end is shown which ha been in use in a roasting furnace for treating zin concentrates containing 28-30 per cent. of sulphu This has already been in use for three months, where the total life of a similar article made of mild steel only three weeks. Various other products are show which indicate the superior service given by Firth stainless steel.

THE *Weather Map* of the meteorological service o the Dominion of Canada for July has recently bee received. It shows the mean temperature and th total precipitation for the month, and graphicall the difference of temperature from the normal an the comparative amount of rain over the whole o Canada. Part of July was exceedingly hot i southern British Columbia and very warm in th North-western Provinces. There was a deficienc of temperature amounting to 4° F. or more in easter Manitoba, northern Ontario, and north-easter Quebec. The precipitation varied considerably i different parts. The Edmonton district of Albert and parts of Manitoba, as well as the northern coas of the Pacific, received from 4 to 6 inches or mor of rain; some regions in Quebec had more tha 5 inches. In the maritime provinces the gener average was less than 2 inches. On the souther coast line of Nova Scotia, moisture from abundan fogs mitigated to some extent the drought, whe rivers and streams are said to be very low and wel are drying up. At the back of the *Weather Ma* the highest and lowest temperatures and the pr cipitation, with brief comments on the weath and the state of the crops, are given for eac station, the latter being of considerable intere generally.

THE first conference of the Pathological and Bacteriological Laboratory Assistants' Association was held on September 1-5, in the Department of Pathology of the University of Edinburgh. The attendance was exceedingly good, there being members present from all parts of Great Britain and also from Africa. The local organisation was in the hands of a committee appointed by the Scottish Division of the Association. Lectures and demonstrations in laboratory technique were held, an exhibition of laboratory work and apparatus was on view, and places of interest in and round Edinburgh were visited. Members of the Scottish Division of the Association were responsible for the exhibition, while the London Division showed objects of tropical interest and demonstrated specimens illustrating the life history of parasites and their insect hosts. At the dinner on Friday evening, September 5, the president, Prof. A. E. Boycott, made the presentation of the first Woodhead medal to Mr. Albert Norman together with an address. This medal has been established by means of funds collected among members of the Association in memory of the late Sir German Sims Woodhead. In all, 141*l.* has now been received and the subscription list is soon to be closed. According to the regulations governing the award which have now been drawn up, it is to consist of a prize and medal, the former being open to members of the Association only. Awards may be made annually or at longer intervals at the discretion of the Memorial Committee.

IT is stated in *Science* that Dr. E. S. Dana, emeritus professor of physics and curator of mineralogy at Yale University, has been elected a corresponding member of the Vienna Academy of Sciences.

APPLICATIONS are invited from honours graduates in physics or electrical engineering for two junior assistantships in the National Physical Laboratory, Teddington. The necessary form of application may be had from the Director of the Laboratory, and returned to him not later than September 27.

THE autumn presidential address to the Radio Society of Great Britain will be delivered at 6 o'clock on Wednesday next, September 24, at the Institution of Electrical Engineers, by Prof. W. H. Eccles, who will deal with the latest developments of the position of the scientific amateur under the Wireless Telegraphy Regulations.

THE twenty-first anniversary of the School Nature Study Union will be celebrated on Saturday, September 27, in the Common Rooms of the London Day Training College, Southampton Row, High Holborn. There will be a reception by the president, Dr. P. Chalmers Mitchell, and an address by Mr. G. H. Gater, Education Officer, London County Council. The general secretary of the Union is Mr. H. E. Turner, 1 Grosvenor Park, Camberwell, London, S.E.5.

APPLICATIONS are invited for appointments as temporary assistant chemists at the Government Laboratory. Candidates must possess the degree of B.Sc., with not less than second-class honours or equivalent, and should have, if possible, experience in investigative work. A form of application is obtainable from the Government Chemist, Clement's Inn Passage, W.C.2. The latest date for its return is September 30.

THE twenty-eighth autumn fungus foray of the British Mycological Society will be held at Bettws-y-Coed, N. Wales, on September 22-27. Mr. J. Ramsbottom will deliver his presidential address, entitled "The Taxonomy of Fungi," on September 24. Other papers to be read at the meeting are by Dr. Harold Wager on an aldehyde reaction in the tissues of fungi, and by Mr. A. W. Bartlett on a new species of Urophlyctis producing galls on *Lotus corniculatus*. Particulars of the foray can be obtained from the General Secretary of the Society, British Museum (Natural History), London, S.W.7.

THE Riga correspondent of the *Times*, in a message dated September 12, states that news had been received from Moscow announcing the arrival at Urga, Mongolia, of Mr. Roy Chapman Andrews, leader of the Third Asiatic Expedition of the American Museum of Natural History, who is seeking permission for the exploring and excavating work which it is proposed to carry out in 1925. This seems to dispose of the fears which were entertained in New York as to Mr. Andrews' safety. It was known there that he was on his way from Peking to Urga, and some anxiety was felt in view of the political disturbances which have been reported recently in Urga.

A LARGE individual of the loggerhead turtle, a tropical and sub-tropical species, was found alive near Dunvegan, Skye, on December 13, 1923. In recording its occurrence (*Scottish Naturalist*, 1924, p. 99) Dr. James Ritchie states that it measured 4 ft. 5 in. in length, weighed 309 lb., and was a female. It contained more than 1000 eggs, and is being mounted for exhibition in the Royal Scottish Museum, Edinburgh. Previous occurrences of the loggerhead turtle in Scotland date back to 1861, when two or perhaps three young specimens were found on the mainland about the same time; a small individual, recently dead, was washed up on North Uist in 1898.

THE British Research Association for the Woollen and Worsted Industries announces the following awards for the year 1924–25: Research fellowships to Mr. R. Burgess, of Nottingham, to enable him to continue his research at the University College, Nottingham, on the bacteriology and mycology of wool; and to Mr. J. E. Nichols, of Edinburgh, to conduct research at the Animal Breeding Research Department of the University of Edinburgh on the relationships between the wool fibres of various breeds of sheep: an advanced scholarship to Mr. H. Maldwyn Williams, tenable at the Scottish Woollen Technical College, Galashiels.

THE following awards for the year 1924–25 have been made by the Salters' Institute of Industrial Chemistry and approved by the Court of the Company:—Fellowships are renewed to Dr. W. G. Sedgwick, Armstrong College, Newcastle-on-Tyne, and Oxford, Fellow, 1923–24, and to Mr. W. Randerson,

Imperial College of Science and Technology, Fellow, 1922–23, and Hon. Fellow, 1923–24 (during tenure of Albert Kahn Travelling Fellowship). Fellowships are awarded to Mr. H. H. Evers, University of Liverpool; Mr. K. Knight Law, University College, Nottingham; Mr. H. S. Pink, University College, Nottingham, and Oxford; and Mr. V. E. Yarsley, Birmingham University. The Salters' Institute has also awarded seventy-two grants in aid to young men and women, employed in chemical works in and near London, to facilitate their future studies.

DURING the forthcoming winter, Mr. H. V. Garner, the guide demonstrator of the Rothamsted Experimental Station, Harpenden, will be available for lectures to Chambers of Agriculture and Horticulture, Farmers' Clubs, Agricultural Societies, etc., on the Rothamsted experiments in regard to the manuring of various crops, the management of farmyard manure, and on chalking and liming. For Students' Societies and similar bodies, lectures could be arranged dealing with the field and laboratory work at Rothamsted. No fee is charged for Mr. Garner's services, but any association engaging him would be expected to defray travelling expenses. All communications regarding lectures should be addressed to the Secretary, Rothamsted Experimental Station, Harpenden.

THE next meeting of the American Association for the Advancement of Science is to be held at Washington on December 29–January 3, and local committees have been appointed. Great efforts are being made to deal with the question of wide publicity for the meeting. Authors of papers are being asked to prepare abstracts of their contributions, and Science Service is again to co-operate with the Association's publicity committee in preparing material for the Press. The meeting will open with the address of the retiring president, Dr. C. D. Walcott, and it is hoped that the President of the United States will also address the Association and the associated societies. Another general meeting will be held on December 31, when Prof. A. S. Eddington will speak on "Relativity." In connexion with the meeting, an exhibition of scientific apparatus, methods, books, and products is being arranged as in previous years. Reduced railway fares have been arranged for members of the Association travelling to Washington from any part of the United States, or from places in Canada east of and including Armstrong, Fort William, and Sault Ste. Marie, Ont.

A DIRECTOR of research is required for the Forest Products Research Laboratories of the Department of Scientific and Industrial Research which are being provided to deal with pure and applied scientific research called for by the practical needs of the using industries and departments of state. The researches will be specially concerned with home-grown and Empire-grown timbers and other forest products. Candidates should possess good scientific qualifications, and a broad experience of the origin and use of forest products. Width of knowledge in forest economy, in the technology and practical problems of the wood-using industries, and in the bearing on these problems of scientific and industrial research, is considered of first importance. The latest date for the receipt of applications (which should be sent to the secretary of the department, 16 Old Queen Street, Westminster, S.W.1) is December 1.

Our Astronomical Column.

MERCURY A MORNING STAR.—Mercury will reach its greatest elongation west (17° 52′) on September 27 and be favourably visible as a morning star. The planet may be seen shining over the eastern horizon about an hour before sunrise. Its position will be in Leo, about 28° E.N.E. of the brilliant planet Venus. On the day of its elongation the planet will rise at $4^h\ 12^m$ A.M., G.M.T., or $1^h\ 43^m$ before the sun.

Apart from the morning stars—Mercury and Venus—the zodiacal light will be strongly visible on clear mornings towards the end of September and the beginning of October, when the moon will not offer any impediment to observation.

STUDIES OF ALGOL VARIABLES.—Studies of the details of the light-curves of these variables, combined with spectroscopic measures of their radial velocities, are of importance from the information they give about stellar masses, diameters, and the degree of darkening of their limbs from atmospheric absorption. Mr. R. S. Dugan is undertaking an extensive investigation of their light-curves by photography at Princeton University Observatory. No. 6 of the Contributions of the Observatory contains researches on five variables. SZ Herculis is interesting from the slight degree of limb-darkening, the slight loss of light at secondary minimum, and the considerable masses, 4·6 and 1·4 of the sun, the spectral types being B8, B9. R Canis Majoris is the only naked-eye star among the five, its normal light being 5·3 mag., and the loss of light at primary and secondary minimum, 0·56 and 0·06 respectively. The masses are small: assuming a mass-ratio of 3 to 1, they are 0·14 and 0·05 of the sun; the spectral type of the primary is FO. Two of the five stars, Y Camelop and RY Aquarii, give indications of limb-darkening. The most conspicuous loss of light at secondary minimum is that of SZ Herculis, 0·24 mag., as compared with 1·83 at primary minimum.

ENCKE'S COMET.—Several photographic positions of this comet were obtained in August by Mr. G. Merton with the 30-inch reflector at Greenwich. They indicate that the date of perihelion will be close to Oct. 31·437 G.M.T., which is 0·008 day later than that predicted by L. Matkiewicz. The comet should be an easy telescopic object at the end of September. The following ephemeris by Matkiewicz is for Greenwich noon.

	R.A.	N. Decl.	log r.	log Δ.
Sept. 21.	$8^h\ 1^m\ 32^s$	35° 12′		
,, 23.	8 20 52	34 12	9·9699	9·8918
,, 25.	8 40 25	32 57		
,, 27.	8 59 58	31 28	9·9372	9·8810
,, 29.	9 19 21	29 46		
Oct. 1.	9 38 23	27 51	9·9004	9·8782
,, 3.	9 56 54	25 44		

Research Items.

ABORIGINES OF THE MALAY PENINSULA.—In vol. , pt. 1 of the Journal of the Federated Malay States useums, Mr. Ivor H. N. Evans gives an account of an pedition to Mt. Gunong Benom, Pahang, undertaken March and April 1923 for the purpose of verifying statement made by Wilkinson in the 1911 Census eport that "the wild tribes on Gunong Benom spoke distinct dialect of their own . . . and it is not ossible at present to say whether this distinction is companied by any racial or cultural differences." s a result of his investigations, Mr. Evans is doubtful hether the census enumerators visited the mountain induced the inhabitants to come down from it. e himself was unable to find any traces of aborigines of their occupation, and, with the exception of two akai-Jakun, no aborigines were found on the western de. On the way down to Kuala Krau an aboriginal ttlement was reached at Galong, near Kuala Krau, nd the inhabitants there, who were Jakun speaking Sakai dialect, informed him that there were no oorigines on Gunong Benom, though Negritos Batek) of Ulu Cheka visited it to collect Ipoh poison. Ir. Evans also obtained information of two divisions f aborigines on the Lompat river, of whom one, the o-ben, is very wild, lives in shelters, does not cultivate ne soil, and uses stone knives for cutting and splitting ood.

THE ART OF THE PAL EMPIRE IN BENGAL.—In a ommunication to the Royal Society of Arts which is ublished in the Society's Journal of August 22, Mr. . C. French points out that the mounds which mark s buried cities and its art are the only relics we ossess of the Pal dynasty. This dynasty reigned in Bengal from the eighth to the eleventh centuries of ur era, when it was overthrown by the Sena dynasty —an event which marked the decline of Buddhism nd the establishment of a new caste system. The ise of the Pal dynasty with the first king Gopala, lescribed as "sea-born," ended a period of anarchy. The art of this early period was marked by simplicity, lignity, and an immanent sense of life and vitality. In the succeeding reign of Devapala flourished Dhiman and his son Bitpala, the only two artists whose names have been preserved. They founded the Eastern School and the School of Magadha respectively. Early in the eleventh century, Pal art had reached its zenith and began to show signs of decline in its more florid style. In the orthodox Brahmanical period which succeeds the Pal dynasty, the art is harder, stiffer, and more conventional, with over-elaborated decoration. The inspiration of the artistic representation of orthodox Hindu deities in the earlier period would appear to be derived from Buddhism and to have declined with it. The importance of the art of the Pal Empire, notwithstanding its local character, lay in its influence on other, and also on later schools of Indian art.

THE BRACHYCEPHALIC SKULL.—Prof. F. G. Parsons has published the results of his study of the brachycephalic skull by means of dioptographic sketches and by the method of reduction of a series to composite sketches from three points of view, together with the detailed measurements, in the Journal of the Royal Anthropological Institute, vol. 54, Pt. 1. It would appear that the length of the dolichocephalic skull depends upon increased growth in its posterior part, while the greater breadth of the brachycephalic skull is due to growth in its temporal regions. The short European skull is usually more prognathous than the dolichocephalic skull. It is also more broad-nosed, and its orbital height is not so great when compared with the whole area of the face. Both as regards width and height, the orbital measurement would appear to be of considerable racial importance; in the Nordic race the orbit is very high, while in both the Mediterranean and the Long Barrow races it is very low. In the brachycephals it comes between, but is closer to the Long Barrow race than to the Nordic.

THE GREAT BARRIER REEF.—The first report of the Great Barrier Reef Committee of the Royal Geographical Society of Australasia is published in the Queensland *Geographical Journal* (vol. xxxviii.). The work of investigation included in this report was mainly of a general nature, but it indicates some of the problems which it is hoped to solve. Attention was particularly devoted to those parts of the reef between Cairns and Thursday Island. Attention paid to the form and size of cays and reefs fully confirmed previous ideas as to the influence of the prevailing south-east wind in developing the forms of coral debris along stream lines more or less parallel to the direction of the wind. Observation did not confirm the contention of Agassiz that "nigger heads" are proof of recent elevation. It appears more likely that the occurrence of these masses of coral is due to the action of hurricanes which tear off portions of the growing reef and wash them to leeward. Another problem of great interest is the origin of the openings through the outer Barrier. The committee discards the theory that these openings mark old entrances to the sea of the present coastal rivers. The evidence rather points to their being coastal valleys of the foundered strip on the edge of which now exists the Great Barrier Reef, although many of the drowned valleys have been silted up to a considerable extent. The sediment from the coastal streams being deposited in the depths of the drowned regions, prevents coral growth in these areas.

GEOCHEMICAL DISTRIBUTION OF THE ELEMENTS.—The distribution of the elements in the earth, considered from the geochemical point of view, is the subject of a series of three papers issued recently by Prof. V. M. Goldschmidt, of Christiania, under the title "Geochemische Verteilungsgesetze der Elemente" (Videnskapsselskapets Skrifter, I., Mat.-Naturv. Klasse; 1923, No. 3; 1924, Nos. 4 and 5.) He regards the earth as having been originally gaseous or molten. On cooling, it passed through a stage in which there were three fluid phases consisting of metal, sulphide and silicate. These three different kinds of molten material separated according to gravity, giving a concentric arrangement, with the metal at the core, next a shell of sulphide matter, and outside this a shell of silicate, around which there was a cover of vapour and gas. The silicate shell separated by crystallisation into heavier and lighter parts, gases escaping from it in the process. In accordance with this supposed differentiation of the materials of the earth into four phases during the process of cooling, he divides the chemical elements into four corresponding main groups, namely, (1) siderophils (Fe, Ni, Co, P, C, Mo, Pt, etc.); (2) chalcophils (S, Fe, Cu, Zn, Cd, Pb, As, Sb, Bi, Ag, Au, Hg, Pd, etc.); (3) lithophils (O, Si, Ti, Zr, Th, F, Cl, Br, I, B, Al, Y, La, Ce, Li, Na, K, Be, Mg, Ca, Sr, Ba, V, Cr, Mn, Nb, W, Sn, etc.); and (4) atmophils (H, N, He, Ne, A, etc.). A further separation of the elements is effected by later differentiation in the lithosphere, during the course of which any residual chalcophils aggregate as sulphide deposits, while

residual atmophils find their way into the atmosphere. According to their isomorphic relationships with the commoner lithophils, the rarer lithophils can be divided into three sub-groups, namely, (1) elements of the first crystallisation, isomorphic with trivalent iron and magnesium, *e.g.* chromium, vanadium, and nickel; (2) elements of the chief crystallisation, isomorphic with potassium, calcium and aluminium, *e.g.* rubidium, strontium and in part scandium; (3) elements of the residual crystallisation, which are non-isomorphic or only weakly isomorphic with the commoner lithophils, *e.g.* lithium in part, boron, niobium, thorium and lanthanum. In the second paper Prof. Goldschmidt deals with the geochemical distribution of the elements in relation to the structure of the atom, while in the third paper he deals with the distribution of the rare-earth metals among minerals.

Weather in West Indies.—A summary of the weather in the West Indies and surrounding neighbourhood for 1923, prepared by Mr. Oliver L. Fassig, Meteorologist in Charge, has recently been published under the superintendence of the Weather Bureau of the U.S. Department of Agriculture. The rainfall was generally deficient, and the annual total was between 25 and 35 per cent. below the normal in Jamaica, Santo Domingo, and Porto Rico of the Greater Antilles, and Dominica and Martinique of the Lesser Antilles. In Porto Rico the total for 1923, 51·63 in., was the smallest recorded in the past 25 years. Rainfall was continuously below normal, over the section as a whole, from January to September and in November. For the three consecutive years—1921, 1922, and 1923—the aggregate deficiencies in rainfall for the area as a whole amounted to 40 inches, and rainfall above the normal was recorded only in 8 months out of 36. Although 1923 was exceptionally dry, October was conspicuous for the frequency of torrential rains. Temperatures during the year were generally slightly above the normal for the area as a whole. The region of the West Indies and Caribbean Sea was remarkably free from cyclonic disturbances. A few errors have crept in, and among those noticed are the statement in the general summary, p. 97, that the October temperature was below the normal; the month clearly should be April. On p. 105 the sea-water temperature at Balbao in the Panama Canal Zone for August is given as 93·1° F., which is clearly 10° too high, and the March temperature given as 69·3° is presumably 10° too low. Monthly Reports are regularly published, based on a large number of observations. These contain, in addition to the ordinary meteorological observations, details of earthquakes which are not summarised in the Annual Report.

Insectan Palæontology.—Entomologists have been following with keen interest Dr. R. J. Tillyard's series of papers on the Mesozoic Insects of Queensland, appearing since 1916 in the Proceedings of the Linnean Society of New South Wales. In his latest contribution to the subject (*l.c.* xlvii. pt. 4) Dr. Tillyard describes further insect remains from the Upper Trias of Ipswich, Queensland. These include a Protorthopteron apparently allied to members of the Upper Carboniferous fauna of Europe, as well as several species of Orthoptera, Odonata, Hemiptera, Neuroptera, and Coleoptera. Among the Hemiptera, both Homoptera and Heteroptera are included, the most noteworthy discovery being a new genus, Triassocoris, belonging to the Cryptocerata—that section of the bugs which comprises our familiar Nepa (water-scorpion) and Notonecta (water-boatman), as well as the large tropical Belostomatidæ to which Triassocoris, though smaller, is nearly allied. In another paper (*l.c.* pt. 3) Dr. Tillyard describes some Permian insects collected at Belmont, New South Wales, by Mr. J. Mitchell. These fossils are of very great importance, as they prove that the late Palæozoic Australian insect fauna included metabolic insects belonging to the living orders of the Mecoptera and the Neuroptera Planipennia, as well as to the extinct Paramecoptera. Dr. Tillyard suggests that this ancient assemblage of insects was part of "a fauna developed in association with the fern *Glossopteris*, in which primitive scorpion-flies took the place of the cockroaches dominant in the Carboniferous and Permian of the Northern Hemisphere." He comments on the comparatively high organisation of these oldest known Australian insects, believing that they immigrated into that region long after the more primitive types had been established in the European area. Two recent short papers by Dr. Tillyard are of interest on account of the remarkable conditions under which the insect-wings described were found. A long-horn grasshopper, probably of late Tertiary age, is represented by a wing-fragment embedded in a large crystal of selenite, enclosed in the actual copper lode worked by the Mount Elliott mine, North Queensland (*Rec. Geol. Soc. N.S. Wales*, x. pt. 2). A new genus of dragon-fly is described (*Geol. Mag.* lx., 1923, No. 706) from wing-fragments discovered by Mr. R. May, of Cambridge, in the matrix of the shell-cavity of an ammonite of Upper Jurassic (Corallian) age, which, washed out of its proper bed, was found in the Boulder Clay of Hertfordshire.

Mechanism of Photosynthesis.—Jaroslav Peklo (*Chem. News*, 129, 1924, pp. 91-94) recently advocates the adoption of Willstätter's scheme as to the rôle of catalase in photosynthesis. The arguments are based on the effect of potassium cyanide on the rate of liberation of oxygen in photosynthesis. This substance (and also hydrogen sulphide and phenylhydrazine) exerts a paralysing effect on catalase action, but not on all other enzyme reactions. The immediate stoppage of photosynthesis on treatment with potassium cyanide is therefore held to show that catalase takes some intimate part in photosynthesis and hence to prove that Willstätter's view is correct.

Fruit Production in Cacao.—In the *Tropical Agriculturist* (lxiii., 1924, pp. 22-26), Prof. S. C. Harland outlines the results of some interesting experiments in Trinidad on the fruit yield of vegetatively propagated cacao plants. A striking feature of the results is the fact that there is no connexion between the average yield of the parent plants and that of their budded offspring. Thus the practice of taking buds from parents of high fruit-setting power apparently has no experimental justification. The author points out that this result is probably paralleled by similar experiments on apple, cotton, and rubber, and he suggests that the ultimate yield of the budded tree must depend not only on the quality of the buds but also on that of the stock on which they have been incorporated.

A High Vacuum Pump.—Report No. 62 of the Research Department, Woolwich, emanates from the Radiological Section and describes a new glass mercury condensation pump for the production of high vacua, designed by Dr. Gilbert West, which has been in use in the Department for some time and is easy to make and clean. The mercury is contained in a glass flask with a long neck, which is kept cool by a water jacket surrounding it. The upper end of the neck is connected to the auxiliary pump, which provides a pressure between an eighth and a thousandth of an atmosphere. A side tube enters the neck

...e lower end of the cooled portion and is bent ...rds so as to be within the cooling water jacket. ...pper end of this tube is connected to the vessel ... evacuated. The mercury is heated to about ...C., at which it has been found the pump as ...ed gives the best results. The vacua obtain... are only limited by the evolution of gas from ...alls of the vessels evacuated, and the rate of ...cation is high.

METALLURGICAL MICROSCOPES.—A new catalogue ...rice list of metallurgical microscopes, outfits, and ...sories has recently been issued by Messrs. James ...i and Son, Ltd., of 81 Tottenham Court Road, ...on, W.1. The microscopes described have been ...ned specially for metallurgical work, and include ...e well-known Jackson-Blount model and the ...ted Metallurgical Microscope. In the latter, the ...n of which is due to Le Chatelier, the objective ...is upwards and is immediately below the stage ...hich the specimen is placed. By reason of this ...n, the necessity for grinding the object parallel ...ounting it in wax or using a levelling stage is ...ated. The present model is provided with a ...nodious stage and improved focussing adjust... The illuminator fitted to both these types of ...oscopes has a reflector which can be adjusted in ...out across the optic axis and can also be tilted ...ltaneously in two azimuths at right angles to ... other, thus allowing efficient and uniform illu...tion to be obtained. The instruments, optical ...pment, and accessories included in the catalogue ...r the full needs of the metallurgical microscopist ...ged either in regular routine work or in original ...rch.

ELECTRICAL CONDUCTIVITY AND BOHR'S THEORY ...ATOMIC STRUCTURE.—The maximum conductivity ...e elements occurs, according to Vegard, when a ... electron is added to the structure in a new orbit. ...r O. Feussner, in the *Zeitschrift für Physik*, July 12, ...s a table showing the probable electronic structure ...lements which are not included in that of Bohr, ... compares the combined tables with the graph ...wing the connexion of conductivity with atomic ...mber. Maxima are found in the case of the alkali ...als, including cæsium and rubidium, in which a ...le electron circulates in the highest orbit group, ... the configuration of the inner electrons is that of ...h preceding inert gas; there are also maxima for ... Ag, and Au; the relation between the electron ...rits of Cu and the preceding element Ni is assumed ...e as follows:

	1_1	$2_1 2_2$	$3_1 3_2 3_3$	4_1
28 Ni	2	4 4	6 6 6	—
29 Cu	2	4 4	6 6 6	1

...very similar to that between the orbits of potassium ...d argon; a similar relation holds between Ag and ... and the metals which precede them in the table. ...ts true that the same relation holds for Co and the ...ceding element Fe, though Co does not show a ...tive maximum of conductivity. Vanadium is an ...mple of an element with one electron in a 4_1 orbit, ...ich does not show a maximum; it has 12 electrons ...the *M* group, while titanium, the preceding element, ...s 10, and two in the *N* group (4_1); such elements ...w no maximum. Cr, Mo, and W have relative ...xima, though the most probable number of ...ctrons in the orbit group with highest principal ...antum number n is two. It has been suggested ...t an examination of the spark spectrum of Cr ...uld decide whether there are one or two electrons ...the *M* group.

EVIDENCE OF INTRA-ATOMIC FIELDS IN SPECTRA.—The effect of strong electric and magnetic fields on the mercury spectrum has recently been described in a paper by Messrs. Hansen, Takamine, and Werner (Det Kgl. Danske Viden. Sels., Math.-Fys. Medd. v. 3). The primary object of the investigation was to see if the lines, $1S - 2p_1$ and $1S - 2p_3$, which are forbidden by the selection principle, could be produced under magnetic or electric influence. It was found that while the former was excited in considerable intensity by condensed discharge, the latter could not be produced at all. The general effect of the electric field was the production of new combination lines, of which the relative intensities, state of polarisation, and displacements in the fields were measured. The general features of the effects were in close agreement with the quantum theory of spectra. Some time ago Dingle pointed out that the spectrum of the flame-arc of mercury in vacuum contained lines of the type $2p - mp$, which are disallowed by the selection principle, and Takamine, in a further paper (*Japanese Journal of Physics*, vol. ii., Nos. 3-5), surmising that the explanation lay in the close gathering of the atoms in the narrow flame so that the intra-atomic electric fields came into play, describes further experiments with a vacuum arc provided with a constriction. The spectra of mercury, zinc, cadmium and thallium were examined. It was found that, at the constriction, many lines normally forbidden by the selection principle were produced. The similarity between the broadening of the lines at the constriction and that produced in the Stark effect led to the conclusion that the appearance of the forbidden lines was actually a Stark effect due to the intra-molecular electric field coming from the close gathering of ions and electrons at the constriction.

THE IRON SPECTRUM.—In the *Japanese Journal of Physics*, vol. ii., Nos. 1-2, Messrs. Nagaoka and Sugiura describe some interesting investigations of the iron spectrum, made with the view of detecting regularities in the arrangement of the lines. The lines were sorted into groups by observing their behaviour in an electric field, the simplest of the effects thus produced being "the enhancement of lines with small displacement towards shorter wave-lengths." Lines affected in this way were found to form triplets, quartets, sextets, and sometimes more complex groupings, all of which were similar to the Zeeman patterns ordinarily formed by the components of single lines when produced in a magnetic field. This suggested that the lines were actually Zeeman components, produced by the strong intra-atomic magnetic fields of the atoms. The separations in the groups—which varied, in groups of the same type, over a considerable range—amounted in some instances to several hundred units of wave number. For example, there are six quadruplets in which a separation having a mean value of 362·9 occurs: the individual separations range from 354 to 372. From the ordinary expression, $\Delta\nu/H = 4{\cdot}7 \times 10^{-5}$ gauss^{-1} cm.$^{-1}$, this gives, on the assumption mentioned, an intra-atomic field of 7×10^6 gauss—in close agreement with the value deduced by Weiss from his experiments on the magnetic quality of iron at high temperatures. One difficulty facing the hypothesis is the fact that the lines in question are themselves decomposed by an external magnetic field, whereas they would be expected to be merely displaced if they were already magnetically produced components of lines. It is remarked also that sometimes one and the same line enters into several different groups. The authors suggest that the intricate nature of the spectral lines of ferro-magnetic metals may ultimately be traced to the existence of intra-atomic fields.

Food Preservatives and their Action.

UNDER modern conditions of civilisation, the question of supplying food to large numbers of people who live at a distance from the actual areas of production, has assumed an importance which can scarcely be overestimated. The problem has been attacked along two lines: first, by means of quicker and more efficient transport; secondly, by the introduction of preserved foods, including under this term both those which are sterilised by heat and also those preserved by exposure to low temperatures. Owing to the loss or partial destruction of certain accessory food factors during the process of preservation, it is essential that fresh food, especially vegetables and fruit, should be available for general use, and this is largely ensured by means of efficient transport between producer and consumer. On the other hand, certain articles of diet, especially meats, which must be transported long distances, must undergo some treatment to keep them in a condition fit for human consumption, and there is no doubt that the most suitable method to employ is one which ensures sterility and its maintenance during transport: thus the meat, after *efficient* sterilisation by heat, may be tinned and kept sealed from the air, or it may be chilled or frozen, the low temperature preventing any microbic or similar growth.

Unfortunately, simple chilling of meat at a temperature just below freezing point will not prevent deterioration on a long voyage: freezing at a temperature of 10° F. is, however, successful, but the meat does not compare so favourably with fresh meat. It has, therefore, been suggested that the process of chilling might be supplemented by the addition of a chemical preservative or antiseptic when meat has to be conveyed long distances before consumption. The substance which has been used commercially to a small extent in this connexion has been formaldehyde, and the question at once arises as to the effect of this substance upon the human economy. In the Interim Report of the Food Preservatives Committee,[1] recently published, the use of formaldehyde as a food preservative is considered, both from a general point of view and also with particular reference to the carriage of chilled beef. The Committee is unanimous in condemning its use, both with regard to its effects on the consumer himself and also from the fact that it can be used to conceal incipient decomposition without, of course, thereby rendering the food unfit for human consumption.

Formaldehyde acts as an antiseptic since it is a powerful protoplasmic poison: its action is, however, not specific for micro-organisms only, but it also reacts with human tissues, combining with the proteins: thus its excretion is slow and so its action is probably cumulative. When ingested it irritates the mucous membranes with which it comes in contact, and after prolonged use may cause inflammation of the liver and kidneys. It also combines with the proteins of foods, thus rendering them less digestible. In spite of these drawbacks, its use might perhaps have been thought less objectionable in the case of chilled meat, where the carcasses, after being placed in the refrigerating chamber, are exposed for a short time only to the action of the formaldehyde in the form of vapour; the air in the chamber is then circulated by fans, and after about half an hour the vapour is removed by a current of fresh air.

In these circumstances it might have been supposed that any organisms on the surface of the carcass would be killed and the meat remain fresh at the temperature just below the freezing point. Apart from the fact that the process is uncertain in its action owing to the uneven distribution of the vapour in the chamber, its success also seems to depend on the cleanliness with which the meat is handled before it is put into the chamber. These considerations tell against the method, and when it is also found that traces of formaldehyde may be present in the meat at more than one inch from the surface, it is seen that the consumer may take in his system quantities of the poison which cannot fail in the long run at any rate, to be injurious.

The Committee concludes, therefore, that formaldehyde should be banned as a food preservative in all cases. This conclusion may be applied also to the use of formaldehyde as an antiseptic in disease. For external application it has its use, but internally any effect it may have upon micro-organisms is counteracted by its simultaneous deleterious action upon the tissues of the body.

[1] Interim Report of the Food Preservatives Committee on the Treatment of Chilled Beef and other Foods with Formaldehyde. (Ministry of Health.) H.M. Stationery Office. 1924. Price 2*d*.

The Free Atmosphere in India.[1]

THE Memoirs before us are by Mr. J. H. Field, who has succeeded Sir Gilbert Walker at Simla, and by Dr. W. A. Harwood. They are of particular interest from the fact that both authors have been connected with upper-air work in England almost from its first conception.

In the introduction, Mr. Field discusses the methods and instruments that were used, many of which were designed by him especially for the purpose; and he is to be congratulated on the success that has been attained.

Owing to the climate of India the ordinary rubber balloons could not be used, on account of the difficulty of storage, and gutta-percha balloons, made up as required, were substituted for them. Mr. Field describes his semi-graphical methods of working up theodolite observations quickly, and gives some very useful formulæ showing the final error in terms of the errors of observation. He finds that too much trust may easily be placed in the two-theodolite method and gives an example in which the four angular measurements are perfectly consistent among themselves and yet the height of the balloon is in error by 50 per cent. He adopted the tail method for general use.

The results of some very useful experiments are given, showing the extent of the errors which may occur owing to the heating by solar radiation of the recording instruments, and also by the inevitable lag of the thermograph. The conclusion reached is that the resulting error is small up to a height of six kilometres, and this is confirmed by the good agreement of the mean values obtained by night and by day. Above 10 kilometres the error is increased by the unfortunate necessity in having to use gutta-percha balloons, the rising velocity of which falls off as their highest point is reached; but up to 12 kilometres it does not seem likely that the error exceeds two or three degrees.

Mr. Field has done a most useful piece of work

[1] "Memoirs of the Indian Meteorological Department." Vol. xxiv., Parts v., vi., vii., and viii.

his memoir should be read and carefully studied by every one similarly engaged: to such it will give many valuable hints.

In Part vi. Dr. Harwood discusses the observations made with kites and registering-balloons over India and the Arabian Sea. He gives first a summary of the results obtained by Field by means of kites, and then deals with the registering-balloon ascents made in India, chiefly at Agra, during the years 1914–18. Of 237 were sent up, 156 instruments were returned, and 152 of these gave usable records, a result which reflects great credit on Mr. Field and his Indian assistants. The figures were handed to Dr. Harwood, on his return from war service in 1918, to be worked up. Dr. Harwood has taken every care to ensure accuracy, and being well acquainted with the many possible sources of error, has only used such ascents as may be reasonably supposed to be free from error, especially from the effects of solar radiation, a precaution needful in view of the slow rise of gutta-percha balloons. He gives particulars of the temperature, humidity, and pressure at various heights in the three Indian seasons—the cool, the hot, and in the monsoon—and also annual means for the density. He carries his tables up to 12 kilometres, and it is only to be regretted that the stratosphere was not reached, and that at least the results from Agra are not published in full detail.

It is not possible to comment on the many interesting points discussed, but the following may be mentioned. The mean annual lapse rate comes out as identical up to 9 kilometres with that of nearly all other stations; so also the daily temperature variation in India, as elsewhere, is confined to the first one or two kilometres. The excessive heat of the hot season is found to be confined to the bottom layer; higher up the monsoon season is the hottest. The high correlation between pressure and temperature is noticeable in Europe is absent in India, perhaps because the short period variations of pressure are too small.

Comment is made on the figures for the equator given by the reviewer in the M.O. Geophysical Memoir, No. 13, and the absence of information as to their source. These figures were formed from the smoothed mean values derived from the few data available at that time. Further observations on the equator are necessary to show whether Van Bemmelen's excellent set of results from Batavia, most of which have been published since then, fairly represent the general equatorial conditions.

Parts vii. and viii. discuss the motion of the free air over India as it is observed by means of clouds and pilot balloons. The year is divided into three seasons, and three separate heights are taken: the height of low clouds, 2 kilometres; of middle clouds, 5 kilometres; and of high clouds, 9 kilometres. These are the heights assigned to the different clouds in the International Cloud Atlas, and Dr. Harwood accepts them as correct for India. Many tables are given showing the direction of the wind and the percentage frequencies for each direction at each height for 15 stations distributed over the Peninsula; in some cases separate values for each month are given. It is noted that cloud observations necessarily refer to cloudy weather and that pilot-balloon observations will refer chiefly to clear weather, and there is some evidence that there is a systematic difference between the two, but it does not seem to be large enough seriously to prejudice the results of using them as equivalent. The figures will be of great interest to any one who is endeavouring to elucidate the cause of the monsoons.

In Part viii. the relation of the monsoons to the general circulation of the atmosphere is dealt with, and the similarity of the north-east monsoon to the circulation over the North Atlantic is discussed. Dr. Harwood finds a very noticeable coincidence between the track of storms and depressions, as shown in the Climatological Atlas of India and in the Meteorological Atlas of the Indian Seas, and the monthly mean directions of the upper winds at the cirrus level. If this be more than a coincidence, and it seems to be so, it has an important bearing on the formation and propagation of cyclones, and shows that their source must be sought for in the upper winds rather than in the surface conditions.

The four Memoirs form a very valuable contribution, not to Indian meteorology only, but also to meteorology in general. W. H. DINES.

The Royal Photographic Society's Annual Exhibition.

THE Royal Photographic Society's Exhibition was opened on Monday, September 15, and will remain open until October 25, with free admission, at 35 Russell Square. The Scientific and Technical Section is probably the largest and in a general sense the most interesting that the Society has ever been able to arrange. Among the astronomical exhibits are photographs of nebulæ made at the Mount Wilson Observatory by the 60-inch and the 100-inch reflecting telescopes, illustrating Dr. Edwin Hubble's proposed general classification of nebulæ, and a frame that shows the different degrees of elongation of elliptical nebulæ. Dr. William J. S. Lockyer, director of the Norman Lockyer Observatory, Sidmouth, sends some striking photographs of star spectra, and what is, with little doubt, the most successful photograph of a meteor that has ever been secured. Various forms of clouds and their changes are illustrated by several contributors, and geological work by one exhibit from the National Geographic Society of Washington. Closely allied to this are several "survey and record" photographs from the United States and Canada, a very notable one being a photograph, by Dr. W. H. Wright of the Lick Observatory, of the Sierra Nevada Mountains in the neighbourhood of the Yosemite Valley, taken from the Observatory on Mount Hamilton. The details shown range in distance up to 135 miles, and several comparative details are indicated which clearly demonstrate the effect of the curvature of the earth in depressing the more distant as compared with the nearer hills.

Among the stereoscopic slides, the set of 50 by Mr. Herbert G. Ponting which illustrate China and Japan, and include the manners, customs, and occupations of the people, are specially notable. The new Section of Cinematography has twenty excellent exhibits by three authors. Press photography, commercial stage photography, lantern slides, colour photographs of many kinds, natural history photographs, radiographs (including the C.D.X. dental X-ray apparatus of Messrs. Watson and Sons, and a series of 18 dental radiographs), photographs transmitted by wireless, and so on, are all shown in their latest and most perfect forms.

Photomicrography in the service of technology and scientific investigation is exceptionally well illustrated. The Research Laboratory of the Eastman Kodak Co. shows the fibres, and their characteristics, that are contained in photographic paper pulp, and illustrate a new method of distinguishing rag and bleached wood pulp, presumably by differential staining and photographing through suitable colour screens. Mr. W. S. Gerecke, of the U.S. Rubber Co., has sent a long series that refer to

the manufacture of india-rubber and the changes that it is liable to. The British Photographic Research Association shows some of its latest results. Results obtained by the "Davon super-microscope," which has given rise to so much discussion of late, are illustrated by several photomicrographs by Mr. J. D. Jacobs, ranging in magnification from 1000 to 4000 diameters, each with a statement of the optical means employed.

Mr. P. P. Quayle, of the Bureau of Standards, Washington, shows a series of six photographs of the phenomena at the muzzle of a 0·45 calibre revolver when it is fired, taken by an apparatus that gives no evidence whatever of its presence in the pictures. A very interesting method of determining the effect of various conditions, such as stirring, changes of temperature, and so on, on reaction velocity by utilising the decay of luminescence in the Japanese ostracod, *Cypridina hilgendorfii*, is illustrated and explained by Dr. William R. Amberson. The "Mutochrome," invented by Mr. C. F. Smith, of Messrs. Adam Hilger, Ltd., is shown in action. By its means any pattern or design may be photographed and then projected full size upon a screen with the possibility of varying almost infinitely the colour and depth of tint of the various elements.

In concluding this necessarily incomplete account of the scientific part of the Exhibition, we wish to point out that in the prospectus this section is divided into eight well-defined sub-sections, each with its separate board of judges, and to ask, for the sake of students, that each of these divisions may be as clearly separated and indicated, in future, in the Exhibition itself. As it is, there is much confusion. According to the Catalogue, "Technical Applications" are scattered in eleven different places; some "Astronomical Photographs" are under this heading and some are under "Technical Applications," and so on. We would also add that it is very pleasing to see so rich a collection of work from the United States, and to be able to remark on the very high standard of excellence of all the exhibits.

University and Educational Intelligence.

LONDON.—H.R.H. Prince Arthur of Connaught has consented to undertake in November the formal opening of the Ramsay Laboratory of Chemical Engineering at University College, instituted in 1923 as part of the Memorial to the late Sir William Ramsay. A full course of study in chemical engineering will be provided in the laboratory in the coming session, leading to the degrees of M.Sc. or Ph.D. in chemical engineering. The course is designed to meet the demands of the manufacturing industries for men trained in the application of scientific methods to the design and operation of industrial chemical processes and plant. Special facilities are provided for research. Particulars can be obtained from the Secretary of the College.

SHEFFIELD.—The Council of the British Cast Iron Research Association has appointed Mr. J. G. A. Skerl to take charge of an investigation on moulding sands, to be carried out in the Refractories Department of the University and in the foundries of members of the Association. Mr. Skerl has for nearly three years been research assistant to Prof. P. G. H. Boswell, of the University of Liverpool.

APPLICATIONS are invited, from Egyptians only, for a whole-time lectureship in chemistry at the School of Medicine, Cairo. The applications, with particulars of qualifications, research work, etc., should be sent to reach the Director of the School before October 10.

A DEMONSTRATOR in metallography and pyrometry is required in the metallurgical department of the Royal School of Mines, Imperial College of Science ar Technology, South Kensington. Particulars of th duties of the post can be obtained from the secretar The latest date for applications is September 27.

APPLICATIONS are invited by the Harper Adam Agricultural College, Newport, Salop, for an Advisor Economist and an Advisory Chemist for servi in Shropshire, Staffordshire, and Warwickshir Candidates must hold a degree of a British universit and should have, if possible, some agricultur experience. Applications, with copies of three recer testimonials, must reach the principal of the Colleg not later than September 30.

DR. RUDOLF STEINER delivered a public lecture o education on August 30 in London, under the auspic of the Educational Union for the Realisation o Spiritual Values, the chair being taken by Mis Margaret Macmillan. He gave an exposition of h work as director of the Waldorf School at Stuttgar where his theories of education have been put to th test of experience, and announced that a school o similar lines will be opened at Streatham Hill, Londo next January. A principle which he holds to be o fundamental importance is the adjustment of edu cational methods and curricula to the biologica changes occurring in the pupil, and, above all, th changes that take place at the age of puberty. Th gives his doctrines a special interest at the preser time, when the question of "secondary education fo all" is being widely canvassed. It is perhaps misfortune that he has labelled them with the portent ous name "Anthroposophy."

PROSPECTUSES for the year 1924–25 have bee received from a number of technical colleges i London and the provinces. The Northampto Polytechnic Institute offers a great variety of course in mechanical and electrical engineering, optica engineering and applied optics, technical chemistry horology, and women's trades and domestic economy The part-time day classes for young persons employe in electrical and optical trades which have, owin to the propaganda work of a well-known electrica firm, been successfully maintained since 1918 despit the discouragement to which continuation classe have been subjected throughout Great Britain, wi be continued. The Sir John Cass Technical Institut provides evening classes for persons engaged i chemical, metallurgical, electrical, petroleum, and th fermentation industries, and in artistic crafts and th tailoring trade. Full facilities are offered in th Institute's laboratories for special investigations an research. The Cordwainers Technical College offer both day and evening classes in the technology o the leather-working industries. The former includ two-year courses in which the scientific an managerial as well as the more practical aspect of the industry are dealt with. A certain numbe of free places at the Imperial College of Science an Technology, South Kensington, are available fo students who desire to undertake post-graduatio study. The Technical College, Bradford, give particulars of three-year Diploma (Associateship courses in textile industries, chemistry, dyeing engineering, physics and, exceptionally, biology Entrants for these courses are required to pass College entrance examination of matriculatio standard if they have not already passed an examina tion of equivalent standard. The College offers als shorter courses, both full-time and part-time, an training in methods of research.

IN view of the efforts being made in Great Britain t foster interest in aviation, and of the announcement o Government support for light aeroplane clubs, specia interest attaches to the facilities available for the stud

...e science of aviation and of the art of flight. In ...dance with the opinion expressed by the Com... on Education and Research in Aeronautics ... "The Imperial College should become the Central ...ol for advanced study in Aeronautical Science," ...partment of Aeronautics was established in 1920–... that the Imperial College of Science and Technology, ...on, with the approval and financial support of ...e Government and under the direction of Sir ...ard Glazebrook. We have received a prospectus ...e reorganised department. It is now under the ...ction of Prof. L. Bairstow, who is Zaharoff ...ssor of aviation, and is assisted by two assistant ...ssors on design and on meteorology, and by ...ecturers on airships, on air navigation, on strength ...ructures, and on engine design. The assistant ...ssorship in meteorology is at present vacant: ...e other posts are filled by distinguished exponents ...eir subjects. As is to be expected, the depart...e: is in the main a school for post-graduate work, ...its aim is in the direction of the encouragement ...search, as well as in the co-ordinating of experi...al work carried out by individual workers at ...perimental stations in different parts of Great ...ain. A complete course takes two years, the first ...g spent in study at the College and the second ...search or in experimental work. A special one-... course is also offered for advanced students, ...terms at the College and the third term in experi...etal work at a research station or at the National ...sical Laboratory, Teddington. The Department ...eronautics at the Imperial College has already ...ieved considerable success: it will no doubt ...me one of the foremost centres of aeronautical ...y in the world.

TECHNICAL and evening classes provided by the ...don County Council opened this week. Last ...on about 120,000 students attended the evening ...stitutes in London and 51,000 the polytechnic and ...nical institutes, making all told about 170,000. ...s was an increase of nearly 7000 over the figures ...r the previous year. Increases in attendance ...urred mainly in the classes for women's subjects ...n for cultural and commercial education; there ... a slight decrease in the numbers attending ...nical classes. Forty years ago the number ...nding the "night" schools of the period was ...000. Despite the increase in numbers since then, ...e fact remains that, even to-day, only about one ...adoner in three continues his or her education ...ond the elementary school stage. Among recent ...elopments may be mentioned the teaching of ...roleum technology, oxy-acetylene welding, classes ...r the scale and weighing industry, and for textile ...ributors, musical instrument making, and an ...anced school of rubber technology, science teach...n in connexion with commodities and the marketing ...mmodities, technical optics, and aeronautics. A ...el of about 10,000 instructors has been appointed ...give the instruction; it is computed that about ...per cent. of these are actually employed in the ...des and professions they teach. The amount ...nt on vocational and cultural classes of this ...cription in London is about 1¼ million pounds a ...r. The bulk of this expenditure is met in equal ...portions by the Board of Education and the ...ndon County Council, the balance being derived ...m the fees of students and endowments. For the ...rmation of parents and older students, an ...strated "Guide to Continued Education in ...ndon" has just been published for the London ...unty Council by the University of London Press. ...is may be obtained from any bookseller at 6*d.* a ...py.

Early Science at the Royal Society.

September 21, 1664. Dr. Wren being desired to defer no longer the making of a larger telescopical moon for the Society, promised to do it against his next coming to London; upon which it was ordered that the treasurer should pay for a globe of that size, which Dr. Wren should choose at Mr. Moxon's. Several experiments were made. [Oldenburg, in a letter to Boyle, dated at London, September 22, 1664, gives some account of what passed at this meeting, where, he observes, they had the company of a Parisian academist, recommended to Sir Robert Moray and himself. I dare say (he says) he will extol our institution and proceedings to the sky, whensoever he comes; though I must say we grow more remiss and careless than I am willing to expatiate upon. Yet this I must say to a person, that I am sure hath a concern for our prosperity, that nothing is done with the king for us.]

September 22, 1679. Ordered—that Mr. Hunt take care to have all the instruments of the Society now in the custody of Mr. Flamstead at Greenwich immediately removed to Gresham College; and that Sir Christopher Wren and Mr. Hooke be desired to go thither, and take what care they can in it; and that in the meantime Mr. Hooke write to Mr. Moore about the same, and desire to have them carefully sent home.

September 23, 1663. The president gave an account of the experiment committed to his charge, about the descending of water purged from air, proposed formerly by Mons. Huygens, and several times tried before the Society; which the president affirmed to hold good upon every accurate trial. He was desired to prosecute the experiment with quicksilver, and to bring in the particulars of the whole success in writing, together with the solution of this phenomenon.—There was read a petition of the fishmongers, presented to the Parliament, concerning the annoyances, whereby the fry and brood of fish is destroyed, and the several ways whereby the same may be preserved. This was communicated by Mr. Graunt.—The operator was ordered to have ready against the next meeting the iron balls for the trying of gun-powder and gold-powder; as likewise the compressing engine; and the dog, for the cutting off a piece of his skin.

September 24, 1662. Mr. Winthrop read his paper concerning the conveniency of building of ships in some of the northern parts of America, there being several reasons, that may be propounded, as motives encouraging thereto. Among these, that it is not a new project the building of ships in those parts, for there hath been sufficient experience already made, there having been every year some built (great or small) for above these twenty years. There were this summer divers here at London, that were built over there, whereof two of about two hundred tuns: there is one now of an hundred tuns in this river, that was built there: there have been formerly some of three hundred and four hundred tuns built there. There hath been also, and is daily tar and pitch made; and much experience hath been made of the masts of those parts; many having been brought over hither.

1677. It was ordered that the officiating secretary taking short notes of all that passes at the Society or Council before the rising thereof, read the said notes in order to see that they be rightly taken.

September 25, 1661. Mr. Croune was desired to try some experiments of the weights of liquors: the lord viscount Brouncker to make the experiments of two pendulums: Dr. Goddard to prosecute his trials of sinking bodies under the surface of the water: Dr. Charlton to try the experiment of the freezing of salt water: Sir William Petty, a discourse on clothing.

Societies and Academies.

LONDON.

The Institute of Metals (Autumn Meeting), September 8.—W. M. **Corse** (autumn lecture): Recent developments in non-ferrous metallurgy in the United States, with special reference to nickel and aluminium-bronze. Some account is given of nickel, its occurrence, and smelting, and of the Orford, Mond, and Hybinette processes of refining. The copper aluminium alloy known as aluminium bronze is next described. This series of alloys has found many important uses, such as for worm gear wheels for motor trucks, automobile parts and other structural pieces requiring resistance to vibratory stresses or fatigues. The addition of lead to the standard aluminium bronze has given a new alloy of good wear-resisting properties. The dream of many a foundryman to avoid the use of sand for moulding purposes may come true, if the new Holley "long life mould" process using these moulds made of cast iron proves to be the success that is at present indicated. This applies to mass production work. There are also references to Ambrac metal, Frary metal, and the nickel chromium iron alloys.

PARIS.

Academy of Sciences, August 25.—M. Guillaume Bigourdan in the chair.—MM. **Bigourdan** and **Giacobini**: Observation of the total eclipse of the moon of August 14, 1924, made at the Observatory of Paris.—F. E. **Fournier**: Safety manœuvres, guarding against risks of collisions of two squadrons, in line of file, having to cross routes during fog.—Guiseppe **Belardinelli**: The resolution of algebraic equations.—Michel **Akimoff**: The approximate expression of Fourier-Bessel transcendentals of several variables, which occur in Kepler's problem.—P. **Appell**: Remarks on the preceding communication.—G. **Sagnac**: Classification of double stars.—T. **Batuecas**: Revision of the weight of the normal litre of methyl oxide. The value found, 2·1097, is in close agreement with that obtained by G. Baume in 1908 (2·1096). The atomic weight of carbon deduced from this is too high (12·033) and hence either the data for the compressibility of the gas require revision or the law of limiting densities of Daniel Berthelot is not rigorous for a gas so easily liquefied as methyl ether.—Léon **Moret** and Georges **Carrette**: Discovery of the marine Lutetian at the Roc de Chère (Lac d'Annecy).

SYDNEY.

Linnean Society of New South Wales, July 30.—Mr. R. H. Cambage, president, in the chair.—Marguerite **Henry**: (1) Notes on breeding Entomostraca from dried mud, and their habits in aquaria. The relative prevalence and persistency of the different species and their method of reproduction under artificial conditions are described. (2) Entomostraca collected in the vicinity of Auckland, N.Z. Of the ten species collected by Mr. T. Steel, one is new and is also the first of the genus Brunella to be recorded from New Zealand. Several of the species have hitherto only been recorded from the South Island.—J. R. **Malloch**: Notes on Australian Diptera. No. iii. Notes on some Diptera—Acalyptratæ, in which two genera (one in Chloropidæ and one in Agromyzidæ) and eleven species (five in Chloropidæ, two in Ephydridæ, three in Agromyzidæ and one in Asteiidæ) are described as new.—G. H. **Hardy**: A revision of the Australian Chiromyzini (Diptera). In 1920 the author published a paper revising the tribe Chiromyzini. The Australian species are here considered. The males of four species, hitherto only known from the female, are included, and another is described as a new species.

Official Publications Received.

Imperial Earthquake Investigation Committee. Seismological
No. 6, July. Preliminary Note on the Great Earthquake of S.
on Sept. 1, 1923. By A. Imamura. (Tokyo: Department of Edu
Illustrated Catalogue of Specimens from Prehistoric Interme
in the North-East of Scotland and preserved in the Anthro
Museum, Marischal College, University of Aberdeen. By Pro
Reid. Pp. 50+2 maps. (Aberdeen: The University Press, 1924.
Report on Tests of Miners' Flame Safety Lamps fitted with Op
Gauzes, carried out at the Mines Department Lamp Testing
Eskmeals. (London: H.M. Stationery Office, 1924.) 3*d*. net.
National Physical Laboratory. Report of the Advisory Comm
the William Froude National Tank for the Year ending December
(London: H.M. Stationery Office, 1924.) 6*d*. net.
Report of the Aeronautical Research Committee for the Year
Pp. 50. (London: H.M. Stationery Office, 1924.) 2*s*. 6*d*. net.
Ministry of Agriculture and Fisheries. Fishery Investi
Series II. Vol. VI., No. 4. 1924. An Account of Investigati
the Cause or Causes of the unusual Mortality among Oysters in
Oyster Beds during 1920 and 1921. Part II. Chemical Report
George Stubbs, Andrew More and John Ralph Nicholls, and
Dr. O. L. Brady. Bacteriological Reports by Prof. J. Eyre. Re
Field Work by F. S. Wright. Biological Investigations by D
Orton. Recommendations as to Further Research by Dr. J. H
Pp. 69. (London: H.M. Stationery Office, 1924.) 7*s*. 6*d*. net.
Apia Observatory, Samoa. Report for 1921. Pp. 62. Report
Pp. 63. (Wellington: W. A. G. Skinner, 1923.)
A Summary of the Meteorological Observations of the San
servatory (1890–1920). By G. Angenheister. Pp. 56. (Wellingt
A. G. Skinner, 1924.)
Kungl. Svenska Velenskapksakademiens Handlingar. Tredje
Band 1, No. 2: Researches on the Distribution of the Absolute Mag
of the Stars. By K. G. Malmquist. Pp. 77. Band 18, No. 23:
of the Properties of Globular Distribution. By S. D. Wicksell.
On the Dissection of Frequency Functions. By C. V. Charlier a
Wicksell. Pp. 64. (Stockholm: Almquist & Wiskells.)
L'Éclipse totale de soleil des 20-21 août 1914. By H. G. Block.
(Stockholm: Almquist & Wiskells.)
Ordnance Survey Map of Roman Britain. Scale 16 miles to 1"
+map. (Southampton: Ordnance Survey.) 4*s*.
Records of the Botanical Survey of India. Vol. 10, No. 1: The
of the Abor Expedition. By I. H. Burkill. Pp. 154. (Calcutta
Government Printing, India.) Rs. 4, As. 4.
Annals of the Transvaal Museum. Vol. 10. Part 4. Pp.
(Cambridge: At the University Press.)
Ministry of Agriculture and Fisheries. Fisheries Investi
Series 2, Vol. 7, No. 2. 1924. Report on Exploratory Voya
Lousy Bank and Adjacent Areas. By Lt. E. L. Pawsey and F. M
Pp. 22+2 charts. (London: H.M.S.O.) 3*s*. net.
Australasian Antarctic Expedition 1911-14. Scientific Reports.
C. Zoology and Botany. Vol. 6, Part 6. Polyzoa. By W. Th
Pp. 22+five text figures. (Sydney: A. J. Kent.) 2*s*.
Astronomical and Magnetical and Meteorological Observations
the Royal Observatory, Greenwich, in the year 1921 under the dire
Sir Frank Dyson. (London: H.M.S.O.) 1*l*. 15*s*. net.
Cape Astrographic Zones. Vol. 10. Catalogue of Rectangu
ordinates and Diameters of Star Images. Derived from Phot
taken at the Royal Observatory, Cape of Good Hope. Commence
the direction of Sir David Gill, and completed by S. S. Hough. Z
(London: H.M.S.O.) 4*l*. 10*s*.
Report of the Aeronautical Research Committee for the year
Pp. 50. (London: H.M.S.O.) 2*s*. 6*d*. net.
Department of Agricultural and Technical Instruction for I
Memoirs of the Geological Survey of Ireland. The Geology of the
castle Coalfield, Co. Antrim. By W. B. Wright, with chapters
Palæontology of the field by E. A. Arber and L. B. Smyth.
(Dublin: The Stationery Office.) 7*s*. 6*d*.

Diary of Societies.

TUESDAY, SEPTEMBER 23.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—E. B. Seymour Nort
Engineer's Life in Eastern Oilfields.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Capt.
Eckersley: The Development of Broadcasting in Great Britain.

WEDNESDAY, SEPTEMBER 24.

RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engi
at 6.—Prof. W. H. Eccles: The Latest Developments of the Pos
the Scientific Amateur under the Wireless Telegraphy Regul
(Autumn Presidential Address.)

THURSDAY, SEPTEMBER 25.

INSTITUTION OF LOCOMOTIVE ENGINEERS (at Engineers' Club, Co
Street), at 7.—Lt.-Col. E. O'Brien: The Future of Main Line
fication of British Railways.

FRIDAY, SEPTEMBER 26.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—O. Broc
The Wilderness of the Wanderings.

SATURDAY, SEPTEMBER 27.

SCHOOL NATURE STUDY UNION (Anniversary Meeting) (at Lond
Training College), at 3.—G. H. Gater: Address.

NATURE

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number : GERRARD 8830.
Telegraphic Address : PHUSIS, WESTRAND, LONDON

NO. 2865, VOL. 114]

University Staffs and University Finance.

THE recent revision of the conditions of tenure and salary of the non-professorial staff at the University of Edinburgh, referred to in a letter published in NATURE of May 24, raises again the whole question of the position of these grades at universities generally, and the extent to which their position is satisfactory alike to themselves and to the institutions they serve. That such staffs believe themselves the victims of grievances is apparent to any one conversant with the present situation at most universities in Great Britain.

During the past quarter century, with the growth of specialisation and the increase in student numbers, a progressive change has occurred in the character of the work undertaken by a large proportion of these staffs. From the stage of being mere personal assistants to the professor, they are now very frequently directly responsible for honours courses and for the supervision of the work of research students. From the point of view both of disseminating existing knowledge and of opening up and exploring new fields of inquiry, they have become an indispensable section of every university.

Unless adequate facilities are provided, however, and the conditions such as to enable these individuals to devote their free time to original reading, thought, and inquiry, it is clear that this work cannot be conducted efficiently. It is notorious that demonstrators and lecturers of various grades, with increasing social responsibilities as they grow older, with no security of tenure, inadequate salaries for the positions they are expected to maintain or the interests they are required to develop, crowded in their grades with no prospect for the great mass of real advancement because of the paucity of higher posts, spend arduous nights away from home, teaching evening classes or undertaking other hack-work to supplement their meagre salaries. It is absurd to pretend that under such conditions their normal duties can be efficiently conducted, and an inquiry into the whole question of payment and the evils that are arising from continued under-payment is undoubtedly urgent before the rot has time to inflict permanent harm on university teaching.

The whole standard of staffing is affected by this question. The obvious lack of prospects of the junior staffs acts as a deterrent upon the better graduate from entry into the profession, and impels the ambitious demonstrator or lecturer, eminently suited as he may be to an academic career, to turn to secondary school teaching, where, with even inferior qualifications, he is certain to rise from 300*l.* or more per annum to 500*l.* or 600*l.* instead of remaining at a fixed salary

of 300*l.* or 400*l.* While it is true that certain individuals will always be attracted to university work, irrespective of the conditions, it is quite clear that the factor of low salaries is operating to drive the better type of graduate into school teaching and government service and to force the universities to retain on their staffs inferior men. The effect of this on our educational system will presently be apparent. While it is essential that the best personnel should be attracted to the academic teaching profession, they will only be induced to enter and remain by offering a career comparable to that obtainable in other fields. This can scarcely be said to be the case at present at Edinburgh, as we are informed in a memorandum issued by a committee of the staff that during the past year the average salary of the members of the non-professorial staff (248) was about 260*l.* and that for the professorial staff (52) about 1100*l.* It may be noted that where the work and responsibility of the one grade shade continuously into those of the other, this disparity in reward is too acute to be regarded as wholesome.

It is, however, not merely with the question of salary that these grades are apparently dissatisfied. While it is a fact that in a few universities, within the past few years, some members of the lectureship and readership grades have been admitted to membership of senates, no adequate scheme of direct representation of non-professorial grades on the senates and governing bodies of universities has been put universally into operation. There is in general no constituted machinery whereby members of these grades may make known their views on matters affecting the general policy of the university and their own interest. Such a state of affairs cannot, of course, endure. The devolution in administrative and educational responsibility and initiative, essential in the modern university, implies on the part of the staff a progressive experience and familiarity with problems affected by university policy which ought, in the interests of efficiency, to be fully utilised. No greater mistake could be made by any governing body than to regard the staff as mere employees or "hands."

Associated with these two aspects of the question, that of finance and that of policy, must be mentioned the tendency which has manifested itself of earmarking increases of capital, whether by gift or otherwise, for the foundation of new chairs or the creation of new buildings. If gifts of this nature are never to be expended on the salaries of the staff, not even towards the salaries of the additional staff required to carry on the work of the new extensions, the position of the non-professoriat must become more acute, especially since it has become customary to discuss the salaries of the latter always in relation to cur income.

From the point of view of the institutions th selves the problem is not easy. Faced with a decr in student membership and revenue from fees, incre in expenditure and decreases in grants, heavy r and requests for the extension of their functions, t lot indeed is not a happy one. The standard teaching must be maintained, the research spirit n be fostered, and the educational needs of a ri democracy catered for.

The problem is twofold—administrative and finan A little, perhaps very little, might be effected increased economies in administration, but in shaping of a progressive and enlightened policy ev thing is to be gained and nothing lost by the ful representation of the staffs on the governing bod On the financial side, however, the position is m more critical. The saturation point has proba already been reached as regards income from fe further increase is, moreover, undesirable in the li of present-day demands for the removal of finan barriers to a university education. Meanwhile, as immediate proposal, if the Government is in earn in its professions on education and on the injust of Local Rating, we see no reason why clauses empting educational institutions from local taxat should not be introduced into the Bill on Lo Rating which we understand it has in contemplati This would in effect secure to universities a contribut from local authorities equal to the present taxat paid by these institutions without the unpleas necessity of begging for such a grant. The suggest seems at any rate worthy of consideration.

In any event, the financial situation of the univ sities in Great Britain is really too critical for a mere tinkering to ease it permanently. All su institutions have more than a merely local inter and as such their finances require to be considered a broader basis. Their functions and responsibilit interweave and overlap, and to require each body produce a budget which balances in itself is fool finance. At what point the universities will be rea for drastic changes it is impossible to say, but so such change is inevitable and probably immine A broadening of the budgeting basis, a closer a more deliberate interlocking of the functions of separ institutions, would probably result not merely in more effective economy in administration, but wo unify the standard of grading in the staffs from university to another. The time is, indeed, ripe a Royal Commission on the financial position of Universities of Great Britain, excluding Oxford a Cambridge.

Rice.

By Prof. E. B. Copeland. Pp. xiv+352+18 plates. (London: Macmillan and Co., Ltd., 1924.) 21s. net.

If all the rice grown in India were planted in the British Isles, there would not be standing room for it. Yet the area under rice in India, with the exception of Bengal, is practically confined to a coastal fringe and is far from supplying the requirements of the people. The *per capita* ration for a rice-eating population would probably fall something short of three pounds a day, and the consumption in India is more than one pound. The staple food in a great tract in the north is wheat (there are 50,000 square miles of wheat in India), while the main cereal food of the population in the remainder consists of various millets. In other words, the ninety million acres under rice in India fall far short of the requirements of the country, and to a large proportion of the population rice is an almost unobtainable luxury. At the conclusion of the Armistice, festive gatherings were held in all parts of India, and at one in which the writer took part, representatives of all the neighbouring tribes were given a substantial meal. It transpired that some of these had never tasted rice, and, the quantity not being stinted, the unique spectacle was witnessed of the emaciated human frame swelling visibly during one short afternoon into comfortable rotundity.

China and Japan are two other great rice countries, and although statistics are not available, it is probable that somewhat similar conditions prevail there also, in spite of a distinctly higher scale of living, for we know that vast quantities of millets are grown in both of them. In northern China wheat is the main cereal. On comparing the maps of world distribution of rice and wheat, these crops are seen to be wonderfully complementary, the former spreading over the warmer portions and the latter over the colder; but the true rice zone has a much more restricted range, being concentrated in the monsoon tract in south-east Asia —Japan, China, India, Indo-China, and the Malay Archipelago.

Outside the region of the monsoons, rice appears sporadically all over the tropics, often being introduced to feed Asiatic labour, and even extends beyond the limits of the tropics into southern Europe, north and south Africa, and the New World (maize, of course, being the staple cereal there); but the area devoted to its cultivation in these parts is practically negligible when compared with that in the monsoon countries named above. The statement that one often meets with, that more than half the human race eat rice, is presumably based upon the large populations crowded into south-eastern Asia, but it should be accepted with some reservation. This appears to be recognised by Prof. Copeland, for he merely remarks that "it is probably the staple food of the greatest number of people."

The book is frankly one-sided, but this may, perhaps, be regarded as one of its greatest merits. Any attempt to cover the whole rice world, with its multitudinous varieties and agricultural practices, would require such a volume or series of volumes as would be a weariness to the general reader, if not out of his reach on account of costliness. We have nothing but praise for the author on the result of his effort, coupled with a sense of gratitude for his summarising, in small compass, the more important literature which has sprung up in various centres as the result of their invasion by western science. Most of this literature is altogether inaccessible, even to students in Great Britain. Prof. Copeland deliberately chooses the United States and the Philippines for his main descriptions of agricultural practice, on the sound plea of his thorough familiarity with the cultivation of rice in these countries. Of the countries dealt with, the United States claim fifty pages and the Philippines forty, while sixty pages are divided into short sections on India, Siam, China, Indo-China, Ceylon, Malaya, Java, Japan, Africa, Latin America, Spain, and Italy; more than half of these pages go to India (13), Java (8), Japan (7), and Italy (8). The rest of the book contains general chapters on botany, climate, soil and water, diseases and pests, seed and varieties, and the uses of rice; and in these chapters there are frequent references to such literature as has been published in all of these countries.

The choice of the United States and the Philippines for main treatment is abundantly justified by the fact that they represent the extremes in climate and agricultural practices. It has been stated that although labour is twenty times cheaper in China than in the United States, rice can be grown at less cost in the latter country. One man can only work one or two acres of rice in China, whereas, with the up-to-date agricultural machinery developed in cereal culture in temperate countries, a man can manage 80 acres in the United States. Yet the average yield of rice per acre appears to be only moderate. Analysing the crops in various countries given in the latest Statistical Year-book of the International Institute at Rome, we find that the greatest yields are obtained in Spain and Hawaii. High yields are also obtained in Italy, Egypt, and Japan; moderate in the United States, Java, India and Indo-China; while very low ones characterise Ceylon, the Philippines and Borneo. Judging from this point of view, the choice of the Philippines would not appear to be so satisfactory, especially as the total

output is very small in comparison with that of the great continental monsoon areas. But no country can be compared with these islands in the variety and picturesqueness of its paddy fields, as is at once evidenced by the two striking photographs of the Igorot cultivation in N. Luzon, fitly illustrating the labour involved through countless generations in terracing the almost impossible slopes among the mountains which are characteristic of the group. We must, however, guard against the idea that these terraces are in any way typical, and refer the reader to the pictures opposite to p. 234 for the more usual appearance of the paddy fields in the tropics. For the rest, the Philippines present sufficiently clear cases of the practices of indigenous tropical rice-growing; and there is always the author's plea as to his own intimate personal knowledge, which outweighs other considerations. His account of rice cultivation in the Philippines is indeed clear and interesting.

Prof. Copeland's agricultural classification of rices could, however, with advantage be somewhat widened, if for no other reason than to emphasise the extreme adaptability of this remarkable plant, on which the author insists. The classes given for the Philippines are four in number: clearing or *caingin*, upland or *secano*, *sabog* or broadcasting, and typical lowland (presumably transplanting). These are all present in India, although, as in the Philippines, the first named is extremely rare and fast disappearing; but at least two if not three classes should be added to make the classification more complete. The most interesting case is that of "dry paddy," which is grown just like many other crops in parts of India, on dry land with small rainfall under intensive dry farming methods. This paddy is drill-sown and best grown on black cotton soil; indeed, we believe that it is one of the curious *payira* crops, which will grow to maturity, once a sufficient fall of rain ensures satisfactory germination, without any further moisture than that of the air. This is obtained by the soil from certain moisture-laden winds ("crop winds," or *payira*), which blow during two or three months of the dry season. Then Indian "wet paddy" should be divided into two classes, which may be called swamp and irrigated respectively; the first, where the seed is sown on the margins of temporary lakes filled by the surplus of the monsoon rains and slowly drying up as the paddy ripens; and the second or ordinary lowland paddy, where it is absolutely necessary that a constant slow current of water four to six inches deep should pass over the ground, thus continuously changing the water. Then there is the "deep water paddy" mentioned by the author in another place: as to this, briefly, the writer has seen the oxen ploughing the land with the water almost hiding them completely, and the crop is said t frequently harvested in boats. It is, of course, obv that each of these methods will only be applicabl distinct varieties of the plant, and the agricult practices are entirely different. Some interes photographs of field work illustrate the chapter on Philippines, and these fairly represent those in monsoon tract.

In the United States section, Prof. Copeland centrates his attention on the irrigated, Californian z which is practically rainless during the growth of crop. The areas in thousands of acres in the principal rice States were in 1920 (the maximum) Louisiana 700, Texas 281, Arkansas 175, and Califo 162, but were considerably less in 1923. The b account given of the first three, the Gulf States useful, but, as good accounts in bulletin form available of the Californian area and much less regarding the other, we should naturally have p ferred a straightforward account of this larger older rice tract. This is especially so because of w we may call the fascinating account given by author of the section chosen, a term which can scarc be applied to such information as we have been a to gather on the Gulf States cultivation.

Turning to the general chapters, the first is appro ately devoted to the botany of the rice plant, and, we gather, this chapter is written at any rate larg by another author. The morphological details of rice plant are not very easy to describe withou series of adequate drawings, and this chapter is illustrated. There is no picture of the rice plant, of any of its parts, and some of the peculiarities, su as the leaf parts, are somewhat difficult to envisa while a clearly drawn longitudinal section of the gr would make much of this and later chapters m easy to read and understand. It is scarcely usual describe a graminaceous flower as "perfect," beca the rice plant has six stamens in place of the us three: the seed is described as "consisting of two t coats, the endosperm and the embryo," and t scarcely conveys the fact that it is built on identi lines with the wheat seed.

In the part dealing with the physiology of w paddy, a review of the literature regarding nitrog assimilation is quoted as showing that the rice pla differs from most others in depending on ammoniu salts rather than nitrates. These conclusions may correct for the free draining soils of Hawaii, but doubt whether they will be so for wet paddy the east. As bearing upon this subject, we m refer to work done by Harrison and others on t soil gases given off during the growth of wet pad in Madras, in a series of six memoirs during the peri

1-1920, which have apparently escaped the authors. Green manuring forms an important part in the local agriculture of the paddy fields, this substance being provided by the weed flora growing during the dry period, any vegetable residues in the soil, and often by large quantities of added matter in the form of special classes of leaves. Harrison, on investigating the result of puddling this vegetable matter, which is the orthodox method of preparing the land for paddy in the east, came across an extremely interesting case of symbiosis, between the rice plant and the surface scum. This scum consists of algæ and bacteria which form an impenetrable gelatinous film on the surface of the water as growth proceeds. The gases escaping from the decomposing green manure get entangled in the scum, and play a considerable part in the nutrition of the crop. On analysis, the bubbles are found to contain methane, carbonic dioxide, pure nitrogen, and free hydrogen, in quantities roughly indicated by the figures 70, 30, 5, and 3 respectively. But as the plants grow the bubbles change in constitution; the hydrogen and carbonic acid disappear and the nitrogen steadily increases in proportion to the methane, until at heading time and onwards it becomes the predominant constituent. The details of this change are too intricate to be dealt with here, but the net result is that the carbonic acid gas is utilised by the algæ for their growth with the usual evolution of oxygen which, unable to escape, highly oxygenates the water and thus enables the roots to live in apparently impossible anaerobic conditions. All of the nitrogen from the decaying vegetable matter is lost in the free state, and Harrison surmises that the nitrogen required by the plant is obtained entirely from the mineral salts stored as nitrate in the soil during the alternating dry period when the ground is covered by the weed flora.

Another much longer chapter, on "seeds and varieties," and mainly botanical, occurs later in the book, and as it considers numerous points dealt with in the first chapter it is a little difficult to understand its complete separation. This is one of the most interesting chapters in the book, and discusses in detail the many difficulties in the way of those who have made tentative attempts at classifying the rices of their locality. Varieties of rice differ morphologically and physiologically, and those which are difficult to distinguish in the first sense are not infrequently totally unable to live under the same conditions. One of the most marked distinguishing characters, perhaps, is the period required by the different rices to mature, a factor which fits in remarkably with the varying length of time during which, in a dry country like India, there is sufficient water available for the growth of the crop. The author dallies with the idea that this varying maturation of the crop may have something to do with the length of day or some similar factor of climate, but this is difficult to apply to India where, in the peninsula at any rate, there is little difference in this respect throughout the year, and there are probably more varieties of rice in India than in all the rest of the world together. A case quoted from memory will sufficiently explain the difficulty in accepting this explanation. In parts of the Tanjore delta, it is the custom to plant two kinds of rice together, a short and a long type (say, 4 months and 9 months). When the short crop is ready, the whole field is cut and the matured rice reaped; this drastic action is said not to injure the long paddy, still in the tillering stage, but even to improve its crop by causing additional branching of the hitherto shaded young plants.

After discussing the attempts of various authors at classifying the rices of their localities, the author presents, in the form of a carefully compiled *questionnaire*, a list of the information required in all future descriptions, covering two and a half pages of small print. Among other interesting details he refers to the uncanny faculty of rice-eating peoples of distinguishing the varieties in the form of rice bought in the market by their flavour and cooking qualities. This experience, gained in the Philippines, also astonished the writer in Madras, when an eminent Indian agriculturist informed him that he was able to distinguish 186 different local kinds by the same characters. Such statements have been received with suspicion in Great Britain and, naturally, would appear incredible to us, who are at best acquainted with only a few kinds, bereft by their preparation of their distinctive flavours and much of their nutritive qualities.

This, however, is not the only case met with of the extraordinary power of discrimination in food possessed by the great races of vegetarians in the tropics, and the writer has been accustomed to describe it as a separate sense which is unknown to the peoples of temperate regions and especially to meat eaters. To bring home the point in another way equally remarkable: in a recent severe drought, almost amounting to the official "famine," in South India, shiploads of Burma rice—practically the only kind which reaches Great Britain from the east—were brought over by the Government; and it is recorded that one of the greatest difficulties encountered by the officials in charge of the famine camps was to induce the starving people to eat this unaccustomed food. Some, possibly in a weak condition, were said to have died of starvation with an adequate quantity of this rice lying before them.

The most important part, however, of this long chapter of 64 pages is the summary prepared by Prof. Copeland of the scientific work, mostly done during the last decade, aiming at the improvement of the crop, both in the East and in Europe and the United States. The crops in the tropics are almost always grown as a mixture of varieties or even species, and it is obvious that the first step is always to separate these, whether by mass selection, which usually comes first, or by the separation of pure lines; and it is in the latter direction that practically all the economic successes have hitherto been obtained. This is the case with wheat, cotton, jute, and other crops, and more so still with rice: almost the only crop in which crossing has been the main line of work is the sugar-cane, which is always reproduced in cultivation by the vegetative method. But the analysis of the separate characters of these crops has also commenced in most cases, bringing with it a world of difficulties, which show that progress along this line in the improvement of crops will be a long and intricate matter.

In the case of rice, the author asserts that the raising of improved varieties by cross fertilisation is additionally handicapped by the form of the flowers. The glumes are so thick and tightly closed until just before or even after anthesis, that natural crossing is of the rarest; and he can only point to one case in which artificial pollination has been successfully accomplished. In this case, the severity of the method, cutting right across the glumes with a sharp pair of scissors and emasculating by fine forceps, seems sufficiently drastic to defeat the ends in view. We may only remark that various scientific workers in India do not appear to have met with this difficulty in crossing rice varieties.

Space limits prevent an adequate consideration of the remaining general chapters, namely, those on climate, etc., pests and diseases, and the uses of rice. The first of these is very short, but the questions that arise are referred to in all parts of the book. As regards the second, rice in the tropics has always been spoken of as a crop which, by its extensive method of cultivation, has escaped the devastation by pests and disease so largely met with in other crops, and this is largely true. Undoubtedly, for various reasons there has been less attention paid to the crop in the tropics than to other cultivated plants; but the formidable summary which is presented in the 50 pages devoted to the subject—largely of work in Europe and the United States—is sufficient to raise doubts as to the correctness of this comfortable preconceived idea. The absence of any picture, beyond a couple of plates by Dammerman of borers in Java, is a distinct loss in this chapter.

The uses of rice, dealt with in the short final cha of 10 pages, are briefly summarised; but, of cour great deal more could have been said about t The statement that the straw is "useless for fod will scarcely be accepted in India (as an example country where pasture is either non-existent or adequate), for paddy straw is the main and often only fodder during the greater part of the yea rice-growing tracts. It is true that this is less ma in Burma, where Indian visitors are accustome deplore the wasteful treatment of the straw; but owing to the sparse population, other sources available for fodder and there is a larger amoun waste land than in any part of India. This sp population is, it may be remarked, the chief re for the export of rice from the east, for padd scarcely ever grown as a "money crop," any n than millets are: it is only when there is a sur owing to an unusually good monsoon that enough be spared to send any to the countries of the w One last point, the use of the word "paddy" is ra strictly confined in the East to the crop and the unhusked product, and the additional meaning, w we have not met with before, of the space between bunds confining the water, is to be deprecated.

C. A. H

Science and Folly.

Foibles and Fallacies of Science: an Account of C brated Scientific Vagaries. By Prof. Daniel W. Her Pp. xiii+294. (New York: D. Van Nostrand 1924.) 2.50 dollars.

"LORD, what fools these mortals be," quotes reader as he lays down Prof. Hering's b "Foibles and Fallacies of Science." Astrology, transmutation of metals, perpetual motion, divinat prophecies, charlatanism, are some of the titles of chapters, and they give a good idea of the content a book which contains much curious and interest information.

But is the title of the book correct? The foibles fallacies about which Prof. Hering writes are certai not those "of science"; they are really those human nature." In fact, the chief interest of the b is the light it throws upon the folly of mankind, only of the so-called uneducated masses, but frequently of the highest intellects of the age.

All branches of science—at least all the older branc —have suffered from the pseudo-scientific and charlatan; in fact, one could judge of the extent which a branch of science comes into contact w human life by the extent of the foibles and falla which have grown about it. It is an instructive st

ry to work out the psychology of the makers of one of fallacy, and as the weather has always been a vorite subject for the pseudo-scientific, we may scully give a little thought to considering the ways of he weather prophets who figure so largely in Prof. Hering's book.

We need not devote much attention to the astrologer, or weather was not a speciality of his; it was only an ncidental. It is in the compilers of almanacs that we rs meet with the professional weather forecaster. Th first of these predicting almanacs appears to have be Old Moore's, which claims 1700 as the date of its irn and is, we believe, still going strong. Similar lmanacs are published in most countries, from which t would appear that there are still people who find hie weather forecasts interesting and probably useful. Tt it is not only unintelligent people who put their rit in such forecasts is clear from the remarks one has requently heard about the weather columns and iagrams which have appeared since the War in one of ur contemporaries devoted to country pursuits, travel n sport. How can we explain this except by that peiliar trait of the human mind which makes us remember those things which fit in with our preconceived ideas and ignore those which would prove us wng? Every success of a forecaster in whom we peeve is remembered, and as we take no particular ice of the failures, our impression—perfectly contentious—is one of unbroken or nearly unbroken uccess. Unfortunately, the same process produces an mpression of a series of failures on the part of the ficial forecaster, for no other reason than that, pecause we are British, we distrust everything official, ice his failures, and take his successes as a matter of ccrse.

What, however, are we to say about the makers of h forecasts? Surely they check their forecasts and nst be painfully aware of many dismal failures? Ay one who has had much to do with this class of wther prophet must have been struck by their great sincerity. There is no money to be made out of wther forecasting, so charlatanism is no solution of l problem. The explanation, and we speak from rch experience, is that these men have as a rule olved a most complicated system on which they base lir forecasts, and these systems are never in their al form. Hence, after every failure they re-examine e grounds on which they made their forecast, and n find that if they had only taken so and so into ount, or put less stress on something else, they would ve got a perfect forecast. The examination, instead making them mistrust their system, rather makes m realise how perfect it is if only it is accurately plied.

Prof. Hering also devotes several pages to rain-making and rain-makers, and describes the chief methods employed, but he does not mention the method, evolved as a result of the visit of the British Association to Australia, of electrifying the upper atmosphere by means of kites and balloons, which was offered to the Australian Government by a gentleman with a very appropriate name. Here again we meet with a remarkable amount of credulity; for in most cases the rain-maker thoroughly believes in his method and is sure it will work if only tried on a sufficiently large scale. There is, however, one clever man who makes a very good living out of rain-making. Mr. Hatfield is prepared to go anywhere and make rain on the principle of payment by results. If Mr. Hatfield makes no rain, he asks for no pay; while if he does make rain, he only asks for payment at the moderate rate of 3000 dollars an inch. His rain-making equipment consists of a huge tank 20 feet high, in which he brews a mystic chemical mixture which he says "opens up the clouds." Mr. Hatfield has been extensively employed on these terms in the United States, apparently to the mutual satisfaction of every one concerned. It is difficult to see anything wrong with this, viewed as a business transaction.

If we have estimated the character and motives of the pseudo-scientific weather prophet correctly, he is not such a bad fellow after all, and probably the same could be said of most of those responsible for the other foibles and fallacies described in the book, but we doubt whether Prof. Hering would agree with us, for he is somewhat hard on scientific folly. G. C. S.

Cambridge Biographies.

Alumni Cantabrigienses: a Biographical List of all known Students, Graduates, and Holders of Office at the University of Cambridge, from the Earliest Times to 1900. Compiled by Dr. John Venn and J. A. Venn. Part 1 (in 4 vols.). *From the Earliest Times to 1751.* Vol. 3: *Kaile—Ryves.* Pp. v + 504. (Cambridge: At the University Press, 1924.) 150*s.* net.

THE death of Dr. John Venn since the preface to Volume II. of this monumental work was written allows the reviewer to pay tribute to his magnificent services to Cambridge history and at the same time to emphasise the value of his son's contribution, not merely to the present volume, but also to the whole work. On him alone will now fall the duty of completing the Appendix, including the corrections and additions to the first three volumes. Isaac Newton apart, the present volume (Kaile—Ryves) does not include the names of many well known to science.

Among those whose names stand out on a first selection we may mention John Ray, the well-known naturalist, Nevil Maskelyne, Astronomer Royal, Thomas Millington, the alleged discoverer of sexuality in plants, and Robert Record, who introduced algebra to Britain. On slightly lower scientific grounds we may refer to Sir Hugh Platt, who conducted horticultural and agricultural experiments at Bethnal Green and in St. Martin's Lane, to John Lumley, who founded a lecture at the Royal College of Physicians, to Thomas Plume, founder of the Plumian professorship, to George Parker, second Earl of Macclesfield, president of the Royal Society, and to Roger Palmer, mathematician and political pamphleteer, afterwards created Earl Castlemaine and more generally remembered through his wife.

If science, however, does not figure prominently in this volume, the active part that Cambridge men played in all the religious and political movements of their time emerges clearly. Thus we find Thomas Legh, much employed in the suppression of the monasteries, and Matthew Mackarel, executed for supporting an insurrection against their suppression. Thomas Percye was one of the most active organisers of the Gunpowder Plot, while Thomas Knyvet searched the cellars of the houses of Parliament and discovered the plot. Several of the regicides were Cambridge men, as was also George Monck, Duke of Albemarle, largely instrumental in the Restoration. The ill-fated James, Duke of Monmouth, was Chancellor of the University, while Titus Oates tried two colleges but failed to secure a degree. Migration from one college to another was much more common in earlier times than nowadays.

Cambridge was also the home of many heretics. Hugh Latimer and Nicholas Ridley were the best known of those who were burnt at the stake. Many others settled in America and the West Indies to escape persecution. The strong position held by Cambridge men among English poets is reflected in the present volume in the names of John Milton, Christopher Marlowe, and Richard Lovelace, while other literary names worthy of mention are Thomas Nash, Thomas Otway, Matthew Prior, Andrew Marvell, and Samuel Pepys. The latter supplies one of the many human touches in a volume of short biographies. Others are found in the accounts of Thomas King, scholar of Eton and King's, who afterwards "kept the coffee-house in Covent Garden, called by his name"; of John Ruddle, the priest who exorcised a Cornish ghost; of Dr. William Oliver of "Bath Oliver" biscuit fame; and of Thomas Reresby, who was fined 1000*l.* in the Star Chamber for boxing the ears of Sir William Wentworth on the County Bench at Rotherham.

Our Bookshelf.

Uses of Waste Materials: the Collection of W Materials and their Uses for Human and Animal F in Fertilisers, and in Certain Industries, 1914–19 By Prof. Arturo Bruttini. (International Instit of Agriculture, Rome.) Pp. xx+367. (Lond P. S. King and Son, Ltd., 1923.) 12*s.* net.

One of the outstanding features of the War the abnormal shortage of food for man and be fertilisers for agricultural use, and of many ot substances regarded as essential for various econo purposes. The urgency of the need led to a dilig search for substitutes, many of which were found am unregarded bye-products and so-called waste mater and among wild and cultivated plants of every desc tion. Many of these substitutes merely supplied need of the moment, and fell into disuse as soon as crisis was past. Others were of more permanent va and in certain cases have retained a definite econo position.

As time goes on it becomes increasingly difficult realise the great amount of work and thought that applied to the discovery and exploitation of these wa materials, and Prof. Bruttini has rendered good ser to the community by placing on record not only det of the commodities themselves, but also a history of legislative and administrative measures adopted by various belligerent countries to deal with these matt No other writer has covered the ground so complet and the "Uses of Waste Materials" provides excellent outline of the information available to d with adequate references to more detailed papers wh such exist.

In outline the book deals first with the legislative administrative aspects, and secondly with the meth of handling waste materials and their various proper and uses. The subject is treated under the four m headings of human food, food for live stock, fertilis and alcohols, oils and other industrial produ though in some cases the same raw material be utilised for several purposes. Wherever possi analyses are given, and for feeding stuffs the appropri rations for different animals are frequently indicat As regards fertilisers, much experimental work has b carried out to test various residues, both as to th actual fertilising value and their relative value when cost of production is taken into account. Many h proved to be uneconomic on the latter score, but tests have indicated various sources of potential m ures, some of which may profitably be exploited. comprehensive table of contents and a number illustrations add their quota to the general usefulnes the volume under review, which should prove a valua work of reference to all agriculturists and to many those associated with industry. W. E. B

The Evolution of Mathematical Physics: Being Rouse Ball Lecture for 1924. By Dr. Horace La Pp. 48. (Cambridge: At the University Pr 1924.) 2*s.* net.

"The profound study of Nature is the most frui source of mathematical discoveries." In this quotat from Fourier, Prof. Lamb gives the keynote of lecture on mathematical physics. He traces the hist

of the subject during the nineteenth century, showing how work initiated on the Continent was brilliantly continued in Britain. The great time of Britain began with Green, who was followed by the Cambridge galaxy, whose enumeration of whom Lamb excludes men still alive and names only Stokes, Kelvin, Maxwell, Rayleigh. Then a time came when Britain went barren and it has remained barren ever since.

What is the cause of this barrenness? Is it that the well of genius has run dry, or is it that in some way Great Britain fails to provide the geniuses with appropriate opportunities? It is a century since Fourier stated the condition of mathematical progress, and in his lecture Prof. Lamb shows how the advances of the nineteenth century in Britain were due to the wide and deep knowledge of both mathematics and physics possessed by the workers. It is necessary to ask to what extent our universities are fulfilling the condition laid down by Fourier and now emphasised by Lamb? The answer is distressing. Not only are mathematics and physics divorced so that a man takes his degree in one or other and not in the two combined, but also the total range of mathematics is being found too great for a man to cover, and the tendency is to give a degree on an increasingly fractional knowledge of pure mathematics. If the present tendency persists, the time will come when each mathematician will have a minute knowledge of his own highly specialised branch and his angle of vision will be so limited as to make any advance impossible for him even in his own branch.

The total range of mathematics and physics as at present treated at Cambridge is too great for any man to cover in a degree course, as is also even the total range of pure mathematics as at present treated. So long as the present treatment of these subjects endures, we shall continue to sink in the slough of uselessness just described, and if the process of subdivision and specialisation is allowed to continue, our sinking will be the more rapid. The health of mathematics in Britain requires that Cambridge should discover a means to reverse this process and should in some way sufficiently condense the essentials of mathematics and physics to enable the individual to attain a real knowledge of both.

Gas Engineers' Compendium: a Collection of Statistics, Formulæ, Rules and Data for the Everyday Use of Gasworks' Officials and Students. Compiled by Experts. Pp. 292. (London: Ernest Benn, Ltd., 1924.) 32*s.* 6*d.* net.

A COMPENDIUM should at least be compendious, that is to say it should be comprehensive, complete, and compact; the information it contains should be accurate. This bulky volume fails to justify its title when tested by any of these criteria. General statistics and statutory requirements relating to the gas industry, gas-making coals, retort settings, purifiers, gas-holders, gas producers, by-products, flow of gases in pipes, and data relating to gas distribution generally, the mechanical characteristics of steel beams, etc. of various cross sections are amongst the subjects upon which information and useful particulars are given. We have failed to find tables referring to values of the elastic moduli of materials (and these are required in connexion with certain formulæ contained in the book), data referring to viscosities of gases, coefficients of expansion of substances, vapour pressures and numerous other physical data with which the gas engineer is intimately concerned. Room could be found for these if the thirteen blank pages, blank parts of pages, and wide marginal spaces characterising the volume were utilised; Kaye and Laby's Tables would serve as an example of the type and format of a volume much needed by the gas industry.

The incompleteness of information contained in the present volume is sufficiently illustrated by reference to the inadequacy of the statement on p. 272 relating to the melting point of firebricks—the value for "ordinary" firebricks alone is given. In like manner, one value only is given for the melting point of an electric lamp filament (unspecified). Inaccuracy of some of the information contained in the volume may be exemplified by reference to the tabulated melting points of magnesium, tantalum, and other substances given on the same page. Values of the specific heats of gases, etc. (p. 273), are given only at ordinary temperatures, and these in some cases are incorrect, and certainly in the cases of air and steam are not the generally accepted values. The mathematical section containing the elements of trigonometry, tables of squares, square roots, cubes, cube roots, logarithms, antilogarithms, and trigonometrical tables is possibly both the least and most useful part of the volume. The information contained in the useful part consisting of 16 pages of this section can be obtained elsewhere at a cost of one penny. This volume contains 292 pages (not all filled) and costs 32*s.* 6*d.* *Verb. sap.* J. S. G. T.

The Rock Tombs of Meir. By Dr. Aylward M. Blackman. Part 4: The Tomb-Chapel of Pepi'onkh the Middle Son of Sebkhotpe and Pekhernefert (D, No. 2). (Archæological Survey of Egypt, Memoir 25.) Pp. viii + 61 + 27 plates. (London: Egypt Exploration Society, 1924.) 42*s.*

THIS is a welcome continuation of Dr. Blackman's work, interrupted for nine years. Another large tomb, full of inscriptions, is here recorded, which had been opened by authorised native diggers, and left to destruction without adequate publication. These tombs of local princes give a detailed view of society some four thousand years ago. The great period of the pyramid builders was ageing to its fall, and pluralities and sinecures were the perquisite of high office. Forty-four titles belonged to the prince Pepionkh; some were the equivalent of modern degrees and honours which we express by initials, but others imply too much work for one man, such as Vizier, Chief Justice, Treasurer, Royal Deputy, Head of the Record Office, Keeper of the Granaries, and so forth. No doubt most of these duties were done by deputy, as he had sixty-four officials under him, all named in his tomb, and duly listed here. Beside these there are fifty relatives, who all had offices, and a hundred and ten dependants who also were thought worth mention. Thus more than two hundred persons all swelled the bureaucracy of this noble and lived on the estates. The good old man lived to a hundred, having "grown old very happily" and "never gone to bed vexed." The king under whom he thus flourished also lived to a hundred, in the peaceful

and fat autumn of that civilisation, soon to be scourged by a Syrian occupation.

The facsimile copies of all the sculptures and paintings are carefully executed, and are fully described; the inscriptions and translations have been discussed before publication, with various authorities. This may therefore be accepted as a final record, a kind of work which no nationality has done but our own, though sometimes executed for foreign patrons.

W. M. F. P.

Excavations in Malta. By M. A. Murray. Part 1. With a Chapter by G. Caton Thompson. Pp. iii+49+21 plates. (London: Bernard Quaritch, 1923.) 7*s.* 6*d.*

THIS record of excavations in Malta covers the work done by Miss Murray and her party in the years 1921–22. The most important site attacked was the cave of Ghar Dalam, in which Mr. G. Despott in the course of his excavation in 1916–17 discovered two teeth, since identified as belonging to Neanderthal man. An area of 40 feet by 60 feet was excavated down to rock, but beyond bones of the hippopotamus, some from a stratum which had hitherto proved sterile, no result of particularly noteworthy importance was obtained. Of the three remaining sites excavated, the most considerable was that of Borg en Nadur—remains on the slope of a spur running up from the bay of San Giorgio, at the top of which is the tower from which the site takes its name. The remains, which are well known to archæologists, include a dolmen flanked by an upright stone. In the area west of this dolmen, to which excavations were confined, a small apsidal building was brought to light which exhibits several points of interest and part of the wall of a forecourt. Miss Murray also examined the chamber behind the dolmen. No satisfactory evidence of stratification was obtained. The objects found included pillars, and pillar blocks, Bethel stones, hammer and polishing stones, a number of small chert implements and three fragments of bronze. The pottery, mostly fragmentary, Miss Murray, following Dr. Zammit, classifies as neolithic and bronze age, assigning a polished gray or black ware to the former, and the red with black decoration to the latter. It has been pointed out, however, that the attribution of the second type to the bronze age rests upon no very certain basis. If Miss Murray's results do not lead to any very decisive conclusions, she has produced a very careful, and therefore valuable, record of a considerable amount of work done in a limited time and at a trying season of the year.

Handbook to the Exhibition of Pure Science. [*British Empire Exhibition.*] Arranged by the Royal Society. Pp. 228. (London: A. and F. Denny, Ltd., 163a Strand, W.C.2, 1924.) 1*s.* net.

UNLIKE most Exhibition literature, which usually has a mercenary motive, patent or concealed, this publication is educational in the best sense of the word. The contributors to it are all investigators in the front rank, and their contributions summarise clearly and concisely all the recent advances in physical and biological science. Part I. contains articles concerning the structure of matter by "J. J.," Bragg, Rutherford, and Aston; relativity and astronomy are dealt with by Astronomer Royal and Eddington; "wireless" to by Glazebrook and Fleming; spectra by Fowl meteorology by Napier Shaw and others; origin of m by Smith Woodward; physiology by Starling, Har Hill, Cathcart; and this list is not exhaustive. Part comprises a descriptive catalogue of the exhibits in Exhibition of Pure Science at Wembley, together w introductory remarks by eminent specialists. In ev case it has been sought to trace the development o discovery or invention from the beginning to the lat application, and to show how the applications origina in research undertaken without any utilitarian moti The handbook will be greatly appreciated, not only those who visit the Exhibition, but also by all who interested in modern science; and those concer would do well to see it placed in the hands of all sen science pupils in the schools of the Empire.

An Essay concerning Human Understanding. By Jo Locke. Abridged and edited by A. S. Prin Pattison. Pp. xlviii+380. (Oxford: At the Clar don Press; London: Oxford University Pr 1924.) 8*s.* 6*d.* net.

IT is possible to appreciate the reason for this abrid edition of Locke's great Essay and at the same time regret its appearance. If it had to be done, no liv philosopher is so qualified to do it well as Prof. Prin Pattison. It is issued for academic reasons and appe to academic purposes. Every teacher of philoso knows that it is useless and undesirable to expect student to read the whole work intensively as he m read, say, Spinoza's "Ethics" or Kant's "Critique Pure Reason" if he would understand those phi sophers. Locke is prolix and also a large part of Essay has lost the interest and influence it had. On other hand, nothing is easier than to direct the stud as to what is important and what comparativ negligible. Abridgments are unwise. However w informed, it is certain, for it is human nature, that reader will suspect that something of importance escaped or been suppressed.

The Electrolytic Rectifier: for Electrical Engine Physicists, and Wireless Amateurs. By N. A. Bruyne. Pp. vii+75. (London: Sir Isaac Pitm and Sons, Ltd., 1924.) 3*s.* 6*d.* net.

THIS is a useful little book and will be helpful electrical engineers, physicists, and radio amateu The electrical engineer will appreciate the theory a the method described of using a rectifier to cha accumulators directly from alternating current sup mains. The book will also enable him to understa better the action of electrolytic lightning arresters. T physicist will find the author's experiments on the of neon lamps with rectifiers suggestive. His expe ments seem worth following up. The thousands radio amateurs who have learnt by experience that h cathode and mechanical rectifiers are fragile and cos to use for charging accumulators from the mains w learn that there are cheaper and no less efficient meth of charging them. The references given will be help to the serious student, and the description of the layer theory shows that it is in fair accord w experiment.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Five- (and Six)-Point Support: "Right as a Trivet."

THE earliest mention of the mathematical principle of Geometrical Fit, in five- and six-point contact, is found in the first edition, 1867, of Thomson and Tait's "Natural Philosophy," p. 131, § 198: "As an additional degree of freedom is lost by each successive limitation of a point in the body to a smooth surface, so such conditions determine completely the position of the body.

"Thus if six points properly chosen on the barrel and stock of a rifle be made to rest on six convex portions of the surface of a fixed rigid body, the rifle may be replaced any number of times in precisely the same position, for the purpose of testing its accuracy."

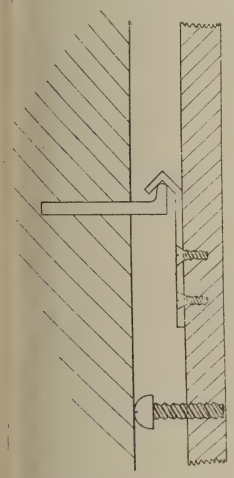

FIG. 1.—Five-point support for pictures on a wall.

This message has not yet received the attention it deserves in the design of mechanical apparatus, for example, the Six-Point Rifle Rest. It is ideal in repetition work such as rifle small arm manufacture, where the parts require to be assembled at random. In Geometrical Fit there is no need for machining of the parts; the fitter's occupation is gone; and "Right as a Trivet" is an exact proverbial description of a perfect mechanical theorem embodying the Axioms of Geometrical Fit.

In the five-point support we proceed to describe, one contact is suppressed, allowing the body one degree of freedom, as we see in the trivet on the bars of a grate, free for a sidelong displacement, but always coming to a steady bearing. The sixth point is encountered by sliding the body on against a stop.

A length of electric conduit tube round a room will serve in the same way for the support of pictures, the tube resting in brackets fastened to the wall at dado height. Hooks on the back of the frame will hold the picture up at an appropriate height, leaving it free to be displaced sideways to any desired position; the cant from the vertical is settled by a round-headed screw in the back lower bar of the frame. The same method can be applied to bracketing out a piece of apparatus from the wall, leaving it free to be lifted off and replaced, and yet quite firm and steady in position.

The wall of a modern laboratory, for appearance and cleanliness, should be not the rough brick surface as at the Cavendish Laboratory, but of glazed brick with a dado some way up from the floor; a mop passed over it will wipe off the dust. A nail cannot be driven into this surface; and so the architect should give instructions for an iron plate to be built into a course of the bricks, at an appropriate level of dado, with a cornice lip projecting slightly; and no more is required for the support of apparatus or blackboard, wherever desired, or however heavy, as in Fig. 1.

If a nail must be driven, a board should be kept for the purpose, and then the board is hung up where required as a blank blackboard.

The method is ideal for a picture gallery, a Royal Academy exhibition. The Academician will stake out his claim and settle the height of his picture, and of the hooks in the back of the frame; and if dissatisfied there is no difficulty in his removal to another site on the wall.

In the oldest Academy of Art, the Pinacotheka on the Acropolis of Athens, the walls are still smooth marble, with no sign of a nail driven, and the professor, our guide, was puzzled how the pictures were hung, until I directed his attention to the groove in a horizontal course, giving the support described above.

Applied to the ballistic pendulum (Fig. 2) the five-point principle requires a suspension of five wires in appropriate spacing, to allow a block or sleeper to recoil parallel to itself; and no consideration is required of centre of percussion or oscillation; the point of impact is practically immaterial. The block moves all together, as in Euclid's definition of a solid body.

The suspension is made from a bracket held up

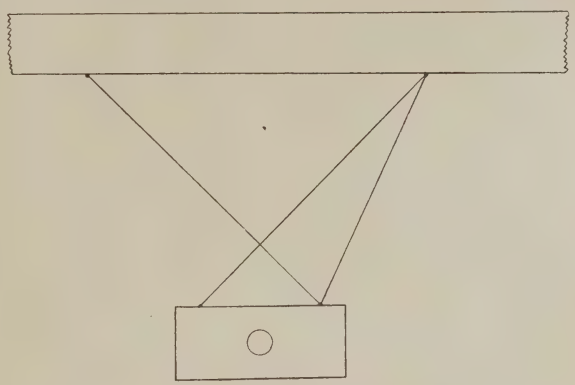

FIG. 2.—Ballistic pendulum.

against the wall in the manner described above; not from the roof, for which the architect never makes provision, and inaccessible at that, especially in a fire with the roof full of smoke. The electric chronograph has replaced the ballistic pendulum for careful velocity measurement, but there are still many applications where the pendulum can prove useful, economical, and accurate.

The psychology of the recruit must be considered at the first introduction to the use of his rifle, so as not to waste confidence in himself by throwing away his first shots. Ordered to lie down on the ground behind a rifle rest designed on this six-point principle, with the rifle in it trained on the target, say at 500 yards, he will be directed what to see on looking through the sights, and instructed in simple snapping practice under the careful eye of his instructor to see there is no flinch or wink on pulling the trigger, going through all the preliminary motions of opening the breech and inserting a cartridge, and ejecting the empty cartridge case by working the bolt. A live cartridge is then inserted without notice, and on pulling the trigger the unsuspecting recruit feels the kick, how it is not formidable with a proper hold. After this he can continue with his allowance of drill rounds, and find all shots in the bull's-eye. He will have acquired confidence in his weapon and himself, and realise that he can continue this standard of marksmanship; if only he holds the rifle straight and himself steady, the weapon and ammunition will do the rest. He is not discouraged at the outset by the

depressing experience of finding all his first series of shots going he knows not where.

In Geometrical Fit there is no need for machining the parts. The parts of a rifle can be stamped out in drop forging, and assembled at random, the natural skin left untouched to avoid rust. The only surface to require machining is a sliding contact, as of the bore of the rifle for the passage of the bullet, and the bolt action of the breech mechanism. When a rifle is assembled and tested by the proof rounds, the opportunity can be utilised of adjusting the sighting at the same time. The rifle is placed in the six-point rest, and the proof rounds fired, without aiming, at a card in the line of fire. The centre of mean impact is then marked on the card, and another workman follows to place the foresight in line on the muzzle, to be brazed on there afterwards. The operation of proving and sighting is thus carried on simultaneously from the same six-point rest.

These principles were too simple to appeal to the Enfield tradition; the complication of the bolt action was adduced as a triumphant refutation when I attempted to explain the theory.

Lord Kelvin had occasion to complain of the dogged opposition of his workmen, and was compelled to put it to them as a personal favour to carry out the six-point idea in his apparatus, allowing them the liberty of classing him as a fool, and paying their wages all the same. At Woolwich I was once just in time to recommend the principle for the suspension of a series of coat and hat racks, requiring to be removable and replaced on occasion. But we did not reckon with the smartness of the sapper artificer, careful to make a mechanical fit sideways, obliterating that degree of freedom.

The use of these brackets was made conditional on the possibility of their removal at a moment's notice. But, as a consequence of the R.E. science, the brackets could not be replaced without an intolerable amount of trial and error, calculable on the algebraical principle of Permutations.

At Finsbury Technical College the advice of Prof. James Thomson was enlisted by Perry for the design of a blackboard, in accordance with his idea of the requirements, and the following description is quoted from "Technical School and College Building," p. 152, by E. C. Robins, 1887.

Prof. James Thomson's blackboard, shown in plate 5 there, is so sensitive to movement, it may be moved up and down with the little finger, although the blackboard itself measures 14 feet wide by 6 feet 6 inches high.

According to Prof. Perry, "It is absolutely necessary the lecturer should not rub out a mathematical formula until the end of the lesson, and this requires a very long blackboard, the longer the better. As one who has to teach mathematics I say a blackboard should not be less than 30 feet long. A long blackboard is usually fixed to the wall. You can write perhaps at 6 feet from the ground to 3 feet, but it saves much needless moving to be able to write all formulas at about 5 feet from the ground.

"It is of importance then to move the whole of the blackboard up and down with a touch of the finger, as Prof. James Thomson's arrangement enables you to do.

"Instead of hanging the blackboard by two chains over four pulleys, and having a very heavy balanced weight for the whole board, involving a tremendous amount of friction, we hang the ends of a well-framed board by two chains from the long arms of two levers; the shorter arms carry a heavy balance weight, and the only place where friction can occur is at the fulcrum of the levers.

"This allows a very large motion of the board for small motion of the balance weight, a great convenience. When these fulcrums are well oiled, a touch of the chalk at any point of the board is sufficient to lift the blackboard."

Vertical grooves give sliding contact, arranged on scientific principles, to render jamming impossible, by the use of only three contacts. But Perry here had the same experience and difficulty as Thomson with the workmen. He complained how after he had been transferred to Kensington, he returned to find the blackboard had been put right by a skilled workman, quite sure the number of supports was insufficient, adding a fourth sliding contact. The result of making what he called a workman-like job was for the blackboard to jam.

However, in a recent visit to Finsbury Technical College, I found the blackboard had been restored again to its original Thomson design, and was in proper working order, easy up and down.

G. GREENHILL.

Mendelism and Evolution.

MEMBERS of the British Association during the recent Toronto meeting have had put before them the available evidence concerning the so-called "White Indians" of Panama. The purely biological interest of the discovery turns out to be as great as the anthropological; and, since it bears on correspondence which has recently appeared in the columns of NATURE, I should like to comment briefly upon it.

In the first place, then, it appears clearly established that the "white" condition behaves as a simple Mendelian recessive. The normal dark colour is completely dominant; there are no intermediates; all the "whites" show essentially the same deviation from normal; white × white gives only whites, but whites may be produced (together with normals) from the mating of two persons phenotypically normal.

The condition has been described as "partial albinism." If by this is meant simply any condition in which normal pigmentation is reduced, the term is applicable; but it should be noted that these people possess yellow hair and hazel eyes.

All the authorities who have examined them are agreed that the condition has no racial significance; the racial type has not been altered save in the one respect of pigmentation, nor can the condition possibly be interpreted as resulting from previous crosses with Europeans. In any case, the discovery that the condition depends on a single-gene Mendelian difference from the normal implies both these results.

Now, however, for the biological and evolutionary significance. Not only are these "mutants" (as they clearly appear to be) perfectly capable of healthy existence and reproduction, but they are coming to form a community of their own. The normally-coloured members of the tribe have a feeling against marrying "whites," with the result that the mutants mate almost wholly with others like themselves, and thus in course of time have formed a nearly closed, self-reproducing community of several hundred souls.

Mutation: consequent preferential mating: consequent establishment of a definite intra-specific unit: with the future consequence that any further mutation occurring within this unit will remain confined to it, and the difference between mutated and type stock thus become accentuated. Here, in man himself, is a case showing with almost diagrammatic clarity how evolutionary change may originate in single mutations of considerable magnitude. JULIAN S. HUXLEY.

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Agricultural Research.

THE address delivered by Sir John Russell, as president of Section M (Agriculture), at the recent meeting of the British Association at Toronto, may be characterised as a somewhat despondent survey of present day activities in agricultural research, with particular reference to those branches of the subject allotted to the Rothamsted Station and the special problems upon which the workers there have been engaged. It may be worth while to give consideration to some of the more general aspects of applied research to which Sir John Russell's remarks inevitably direct attention.

When philosophers, as they then called themselves, first turned their attention to the problems presented by the life of the plant, they were not long in finding that the pioneer science of chemistry enabled them to throw an immediate light on what we may now regard as the crude fact, that plant life is dependent for food upon an adequate supply of certain elements, such as carbon, nitrogen, phosphorus, and potassium. It was an easy step to supply some of these elements by "artificial" means. The result was that, dating from the forties of the last century, the practice of applying "artificial" manures received an immense impetus: so much so that farming practice was almost revolutionised. It became possible not only to raise the level of food production from a given area of land, but also to maintain that level indefinitely.

The material consequences of these early discoveries were so great that they created a belief in the efficiency of scientific research as applied to husbandry which has been held to justify the expenditure by the State, as well as by other agencies, of larger sums than have hitherto been devoted to research of any other description. But during the last eighty years science has presented only one other gift of an economic importance equal to that just indicated. Mendel and his belated disciples have taught us to regard the plant as a plastic organisation which can be systematically moulded in desired directions. Sir John Russell has catalogued the remarkable results of the work of Biffen and others.

Yet it cannot be denied that the agricultural sciences have made great advances in other directions in these long years. Our knowledge of the factors concerned in the growth of animals and plants is almost inconceivably greater than it was eighty years ago. Why is it then, that, as judged by economic tests, farming practice has been so little modified that even Virgil's "Georgics" may still be read as a textbook? One reason may be suggested. The growth of a plant or animal is affected by a number of environmental causes beyond human control. A severe hailstorm, a rainy season, may render nugatory all the efforts of the most skilful and scientific husbandman. He earns his living really by virtue of the law of averages. If old tradition is right, he rings a cycle of changes in a lunar period of nineteen years. It is a fair inference, therefore, that he is not likely to be much moved by scientific evidence that a certain course of action will produce a better result *of the order of difference* that he associates with a normal seasonal variation. If, for example, the supposition is made that the yield of any crop on a particular field will vary normally by 10 per cent. from year to year, a scientific improvement, which, if adopted, increases yield by 10 per cent. in any one year, is scarcely likely to interest the husbandman. It may be, therefore, that science has failed to produce discoveries of sufficient magnitude. "Artificial" manuring, it is true, may be said to have been a discovery of the order of 100 per cent.; and the science of plant-breeding may be said to have involved differences of the same order.

In Sir John Russell's address, consequently, one detects a feeling of disappointment. We have passed through, he says, a "pioneer period with . . . the disadvantages of certain lack of perspective, failure to follow up important issues, and some narrowness of outlook." He suggests that steps should be taken to secure the co-operation of a team of workers in every science bearing on agriculture—the members to be drawn from all parts of the British Empire. The proposal is scarcely in the region of practical politics. After all, the epoch-making discoveries of science have not come from team work—nor from what is sometimes termed "directed" research.

The Member of Parliament and the Treasury official are apt to think of research as if it functioned like a penny-in-the-slot machine—a mechanism which unfailingly gives "results" for the inserted coin. Such and such an industry should form a Research Association, accept a grant, and forthwith grind out results good for the industry concerned. The whole history of scientific effort, however, is a record of individual successes in so-called "pure" science, and, with due respect to the Director of Rothamsted, what appears to be wrong with agricultural science is that it is too agricultural. If, as he says, the "co-operation of a plant physiologist" is needed, let us take care that the worker is not tied to the study of agricultural plants, and if, in consequence, he is a worker in "pure" botany, let us see that he gets as liberal a grant as his brother working in agricultural botany. At the present juncture, research in pure botany is languishing in all our universities, and yet, on Sir John Russell's admission, the advances made by one branch of the science, that of plant-breeding, have far outdistanced any discoveries in the sciences with which he is directly concerned.

The lesson one may venture to extract from the address of the Director of Rothamsted is that it is high time that the State turned its attention to the need for fostering scientific research in pure science. Directed research, that is, research directed to secure definite economic results, is in danger of becoming outworn for lack of draughts from the *pocula sacra* which University research in pure knowledge exists to provide!

CANTAB.

The Vibrations of Air in Organ-Pipes of Unusual Shapes.

IN an interesting letter published in NATURE for August 30, Principal J. A. Aldis discusses the vibrations of air in organ-pipes of unusual shapes, and gives a number of elegant formulæ for calculating the frequencies of the tones in certain cases. The date of the investigations (1867–1868) gives them a special interest, since they were carried out some three or four years before the publication of Rayleigh's well-known paper on "The Theory of Resonance," in which, by the introduction of a quantity which he called the "conductivity" of an orifice, he was enabled to give a simplified treatment of the theory of bottle-resonators and of pipes with restricted mouths.

I was at first somewhat surprised to see that the formula given by Principal Aldis for the frequencies of the tones of bottle-pipes agreed satisfactorily with observations, apparently without any restriction as to the size of the bottle. The formula is obtained by assuming the existence of stationary plane waves in the two parts of the bottle—*i.e.* in the neck (or mouth part) and in the stopped part—and the continuity of the pressures and velocities at the

junction of the two parts. The formula is

$$\tan mh \,.\, \tan mk = \frac{\text{area of mouth part}}{\text{area of stopped part}}, \quad . \quad (1)$$

where h is the length of the mouth part, k is the length of the stopped part, and m is $2\pi/\lambda$ or $2\pi n/a$ (n = frequency, a = velocity of sound). While this formula might be expected to be satisfactory in the case of bottle-pipes with parts of moderate length, it would, I think, scarcely be expected to hold good if the length of the bottle were much less than a quarter of the wave-length belonging to the fundamental tone of the bottle. In such a case we should expect to get better results by using Rayleigh's formula for the frequency of a Helmholtz resonator, namely—

$$n = \frac{a}{2\pi}\sqrt{\frac{c}{Q}}, \quad . \quad . \quad . \quad . \quad (2)$$

in which, for a bottle-pipe, c would be the hydrodynamical conductance (Rayleigh's "conductivity") of the mouth part and Q the volume of the stopped part. It appears from this, therefore, that for small bottle-pipes the important factor is the *volume* rather than the *length* of the stopped part.

The point to which I wish to direct attention, however, is that, notwithstanding the apparent diversity of equations (1) and (2), Rayleigh's equation (2) can be obtained as a limiting form of (1) when h and k are made small compared with the wave-length. In this case we have approximately $\tan mh = mh$ and $\tan mk = mk$, and if σ_1 is the area of the mouth part, and σ_2 the area of the stopped part, we obtain

$$m^2hk = \frac{\sigma_1}{\sigma_2},$$

or

$$n^2 = \left(\frac{a}{2\pi}\right)^2 \cdot \left(\frac{\sigma_1}{h}\right) \Big/ \sigma_2 k.$$

Since σ_1/h (area divided by length) is the conductance of the mouth part (end-correction being neglected) and $\sigma_2 k$ is the volume of the stopped part, we have

$$n = \frac{a}{2\pi}\sqrt{\left(\frac{\sigma_1}{h}\right)\Big/\sigma_2 k} = \frac{a}{2\pi}\sqrt{\frac{c}{Q}}. \quad . \quad . \quad (3)$$

It appears, therefore, that either of the two forms (1) or (2) may be used for obtaining the approximate frequency of the fundamental tone of a small bottle-pipe. Rayleigh's formula, however, has the disadvantage that it does not help us to discover the frequencies of the overtones.

If in equation (1) we suppose h, but not k, to be small compared with the wave-length, we have the case of a pipe with a narrow mouth. Equation (1) becomes

$$mh \tan mk = \frac{\sigma_1}{\sigma_2},$$

or if $\sigma_1/h = c$ (the conductance of the mouth),

$$\tan mk = \frac{c}{m\sigma_2}, \quad . \quad . \quad . \quad . \quad (4)$$

an equation which was given by Rayleigh in 1871 ("Scientific Papers," vol. i, p. 46, equation (15); the right-hand side is inadvertently shown with a minus sign).

Again, if k but not h is small compared with the wave-length, we have the case of a long tube connected with a reservoir. Equation (1) becomes

$$\tan mh = \frac{\sigma_1}{m\sigma_2 k} = \frac{\sigma_1}{mQ}, \quad . \quad . \quad . \quad (5)$$

Q being the volume of the reservoir. This equation was also given by Rayleigh.

E. T. PARIS.
Signals Experimental Establishment,
Woolwich Common, London, S.E.

Abney Sectors in Photometry.

THE following may be of value to those interested in photometry.

The instrument known as the "Abney Sector" used for reducing, for photometric purposes, the intensity of powerful illuminants, such as searchlight projector arcs, by means of a rotating disc fitted with continuously variable sectors, is difficult to construct, and, unless perfectly made, is liable to stick at high speeds.

I have found the following a simple and efficient instrument.

A disc 12 to 18 inches in diameter, in which curved edged V-shaped slots are cut (Fig. 1), is mounted vertically on a board together with a driving motor. Between the illuminant and the disc, close to the latter, but mounted separately, is a screen in which is cut a small rectangular aperture. The beam of

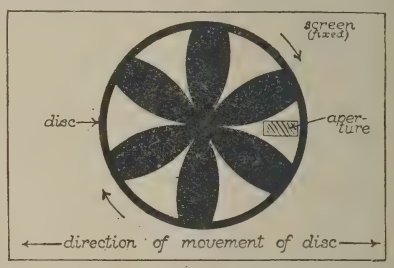

FIG. 1.

light under investigation passes from the source through the aperture and interruptedly through the rotating sectors of the disc to the photometer. The rays are alternately obstructed and allowed to pass by the sectors of the rotating disc, just as in the case of the Abney Sectors. By moving the board on which both disc and driving motor are fixed with respect to the aperture, more or less obscuration as desired may be obtained.

The board may move in a groove graduated to show degrees of obscuration.

G. F. WOOD.
Forest Research Institute,
Dehra Dun, July 12.

Aurora, Potential Gradient and Magnetic Disturbance.

IN view of suggestions which have been made from time to time that a relationship may exist between the intensity of the earth's electric field and the phenomena of the aurora, or of terrestrial magnetism, the available data from Cape Evans—the winter quarters of Capt. Scott's last expedition—have been examined. The original intention to make a comparison between the auroral data and the potential gradient data was formed on the publication of the first meteorological volume. This intention was stimulated by the fact that the time of maximum of the daily variation in potential gradient at that station lay between the time of maximum frequency for auroræ (4 A.M.) and the time of maximum magnetic disturbance (10 A.M.)—in time of the 180th meridian. In addition, Dr. Simpson has recorded slight anomalies in temperature and in pressure at the time of day when the aurora was most frequently observed. By the courtesy of Dr. Simpson, copies of the original data for potential gradient were made available, but it was found that the hours during which conditions were favourable both for observations of aurora and for potential gradient measurement (wind less than 10 miles per hour) were not sufficiently numerous to repay investigation.

On the other hand, it is known that the activity of e aurora is related to magnetic disturbance, and ta exhibiting this relationship have been published reports of the Expedition ("Terrestrial Magnetism" d "Observations on the Aurora"). In these rcumstances, Dr. Chree kindly lent his original ures for hourly character number (representing agnetic disturbance), and these were used for making comparison with the figures for potential gradient ring winds up to 5 miles per hour, for the period arch 1911 to February 1912.

For the purpose of this comparison, the potential adients corresponding to Dr. Chree's magnetic aracter numbers (0 = slight and 2 = great magnetic isturbance) have been meaned for all hours during nich the wind was not greater than 5 m.p.h. Generally eaking, the mean gradients corresponding to these aracter numbers vary during the course of the day nilarly to the curves shown on p. 315 of Meteorology," vol. i. The mean value for the ar corresponding to

Character number 0 is 89 volts/metre.
,, ,, 1 is 90 ,,
,, ,, 2 is 96 ,,

aking, however, means for each hour of the day, id allowing equal weight to each hour, the corre-onding numbers are 88, 89, and 91. The evidence ems, therefore, to be against any direct connexion etween magnetic disturbance and potential gradient this station.

Figures have been derived for the mean value of e potential gradient at each hour of the day, for ur periods of three months each, and these figures so do not encourage much hope in the reality of ch a connexion. The mean values for the four arters (commencing for convenience in February, id equal weight being allowed to the mean value for ch hour of the day) are :—

Quarter.	Magnetic Character Number.					
	0		1	2		
Feb. to Apr.	82 (82)*	volts/metre	81 (83)*	88 (88)*	volts/metre	
May to July	77 (76)	,,	77 (78)	78 (78)	,,	
Aug. to Oct.	93 (93)	,,	93 (94)	93 (96)	,,	
Nov. to Jan.	106 (111)	,,	98 (99)	107 (107)	,,	

* The figures in brackets represent the corresponding means when each servation during the quarter is given equal weight.

C. S. WRIGHT.

Wey Lodge, Portmore Park,
Weybridge.

A Substitute for the McLeod Gauge.

THE letter in NATURE of August 23, p. 276, fails justify an attack on the McLeod gauge. The eory that water is absorbed by glass is a theory ly, of which there is no proof, and there is no proof at the McLeod gauge reads incorrectly or even at it is inconsistent. Any variation can be observed ly by comparison with another method of measur-g low pressure, which is just as likely to vary or be consistent as the McLeod gauge. Animal emana-on, the glass-blower's breath for example, is very ifficult to dislodge from the surface of glass and ight easily cause a disturbance in the electric spark henomena.

A final pressure of 0·001 mm. is mentioned; this eans a pressure which will support a column of *ercury* 0·001 mm. high. The McLeod gauge is the nly practical means of determining this measurement irectly.

In a former letter we were told that the McLeod gauge may have special uses (such as the calibration of other gauges) "under rigidly controlled conditions." This can only mean clean glass, pure mercury, and an efficient drying medium, but it goes to prove my assertion that "there is no substitute for the McLeod gauge, in its perfect measurement of low pressures, expressed in height of mercury column."

HENRY A. FLEUSS.

47 Albert Road,
Caversham, Reading,
September 4.

MR. FLEUSS's letter answers itself. But may we trespass on your space for the last time in order to correct a misunderstanding which others than Mr. Fleuss have shared, and for which our original letter was doubtless responsible?

We never intended to deny that the McLeod gauge, used rightly, is a thoroughly trustworthy instrument and almost indispensable for the calibration of all other gauges, except possibly the Knudsen. But we deny that, as it is often used, it is trustworthy or convenient. It is still, or was recently, an almost universal practice to attach a McLeod to every pumping system and to take readings on it a few minutes after the apparatus has been exposed to the air, and long before the condensed water is removed from the glass. McLeod gauges used in such circumstances are, we repeat, "cumbrous and misleading devices," "mere relics of the past." They are responsible for the ridiculous underestimating of pressures which is still common in the papers of serious investigators. It is for gauges used in such circumstances that we advocate the Pirani gauge as a substitute. Its increasing use shows that we are not alone in our opinion.

N. R. CAMPBELL.
B. P. DUDDING.
J. W. RYDE.

Chimæras Dire: Transplantation of Heads of Insects.

I AM sorry that Prof. Przibram (NATURE, September 6, p. 347) should think that I treated Dr. Finkler's statements with unbecoming levity. The object of my letter was simply to direct attention to Dr. Blunck and Dr. Speyer's criticisms of Dr. Finkler's work and not to express agreement with one side or the other. Now that Prof. Przibram has undertaken to reply to these criticisms, the accuracy of my brief summary is perhaps no longer a matter of great importance, although I fail to see that it is in any way seriously misleading. It is true that I ought to have written "thorax" instead of "wing-cases," and also that Dr. Finkler has not yet told us with what he fed his inter-specific monsters; but I still think that the sentence "a male head led a female body into unwonted perversities" is not an unfair version of what Dr. Finkler has said. To those of us who have only a scanty knowledge of the subject it seems a less extraordinary thing that "the male head kept its usual reaction towards the female . . . when transplanted to a body of opposite sex" than that the body should acquire a new reaction as a result of the operation.

The complaint that Dr. Finkler had refused to submit his specimens for investigation by others was not mine, but was made, as I stated, by his German critics. The specimens which Mr. Boulenger brought to London have been repeatedly exhibited here. I was told that they were not to be submitted to dissection or section-cutting, but I am now informed that no such condition was imposed by Dr. Finkler in handing over the specimens.

W. T. CALMAN.

British Museum (Natural History),
London, S.W.7.

Biology and Religion.[1]

By Prof. J. S. HALDANE, F.R.S.

FOR religion the world, whether visible or invisible, is the manifestation of God. The real basis of religion lies in our own conscious experience, in our awareness of values which determine the course of our existence and unite us all but cannot be regarded as derived from either individual or collective self-interest. In so far as we realise these values, their objective reality, and their unity, we acknowledge, whether we are aware of it or not, that our universe is a spiritual universe and the manifestation of one God.

The theories of natural science seem to recognise neither objective ethical values nor God. Yet many scientific men have been deeply religious, and in one way or another have, even though often unsatisfactorily, reconciled their science with their religion. With the progress of science in recent times such reconciliation has seemed to become more and more difficult, and the existence of spiritual reality in the sense implied in religion has seemed to become more and more shadowy. During the nineteenth century this process was very marked; and it was particularly the progress of biology, and only to a minor extent that of historical criticism, that brought the difficulty to a head. I shall endeavour in this paper to indicate what seems to me the cause of the difficulty, and to maintain at the same time that however uncompromising the attitude of biology is, and I hope always will be, towards obsolete details of theological creeds, there is in reality nothing to come between biological science and real religion.

Perhaps we can best realise the cause if we call to mind the argument of a once popular book, Paley's "Natural Religion." Paley argued that, first, the human or animal body is a piece of exquisitely perfect machinery; and that, secondly, the existence of this wonderful machinery is clear evidence of the existence of a superhuman Designer. His argument was not very original, but it was at any rate put with great clearness. The first step came to be accepted by the great majority of physiologists; but the second step was invalidated by the discovery of evolution and the theory of natural selection. It is, however, to the first step that I wish to direct attention; for the essence of the whole matter is there.

Granted that the body is a machine, Paley would have said that the soul is placed within to control its voluntary working. Nevertheless, the more the matter has been investigated the more clearly has the fact seemed to emerge that the conscious control of the machine is dependent on exactly the same sort of material conditions as its ordinary unconscious working. We need only, for example, reduce the oxygen supply, or cut off the supply of some substance supplied by a gland, to produce not only loss of normal conscious control, but also a condition akin to, or identical with idiocy. If, therefore, the body depends upon mechanical conditions, so also does the mind or soul. Moreover, moral and mental characters are just as clearly transmitted by ordinary generation as bodily characteristics. In Paley's time, and indeed for long afterwards, many physiologists believed that there is active in the liv body a factor which they called vital force, whic independent of the mechanical conditions. But observations just quoted are fatal to vitalism also.

Paley's first step, taken in conjunction with further development of physiology, thus leads straight towards what is called materialism. C sciousness becomes a mere mysterious accompanim of mechanical processes; and spiritual values ha ultimately no more meaning than they can have in purely physical world.

Paley was a product of his time. With his generati and succeeding generations, he accepted the assun tions about the nature of visible physical reality wh had come down to him from Galileo and Newton. Th assumptions were that visible reality consists of s existent bodies separated from one another in s existent space and time, and acting on one anotl according to the definite laws of mechanics, physics a chemistry. The human body, as a part of visible reali must be just as much subject to these laws as inorga bodies.

But Newton's conclusions about visible reality w based on the observation of inorganic phenomena. Th seem to fit these phenomena, or at least seemed un recently to fit them, though Newton himself was from thinking that he had done more than make beginning of applying them in detail. But do they the phenomena of life? If they do not, then Pale first step was a false one, and the materialistic c clusions which have so naturally grown out of it fall the ground. From the purely scientific point of vi of biology itself, the question is fundamental. one can doubt that the conception of a living organi as a mechanism such as Paley depicted is to a very la extent useful and convenient; but is such a concepti consistent with the characteristic phenomena of l and conscious behaviour? To this scientific questi I have largely devoted myself since my student day

If we observe the relation between physiologi stimulus and response we find that, under standardis or "normal" conditions of environment, the respon follows the stimulus as regularly as any physical effe follows its cause. But when the conditions of enviro ment are altered, perhaps to only a very slight degr this is no longer the case: the response is altere perhaps totally prevented or "inhibited," to use physiological term. The exact response of a lim for example, to a stimulus, say a visual stimul acting on the body, depends on a host of stimuli varyi in nature with the relative positions of the various par of the body: depends also on endless other co-existe stimuli, whether visual or of other kinds. It is just t same with chemical stimuli acting on any part of t body whatsoever.

When we regard this phenomenon from a wid point of view, we see that we can with very considerab success predict what happens if we assume that the li of an organism is something which actively asserts an maintains itself, including the organism's relations to i environment, in a manner which is specific or "normal

[1] From a paper read at the Conference of Modern Churchmen, at Oxford, on August 28.

responses and their modifications or inhibitions fall into intelligible order. Apart from this assumption, characteristic physiological responses are nothing but unintelligible chaos: we cannot predict the characteristic manner in which stimuli and responses become associated and effective.

That the parts and activities of a living organism exist relatively to one another is evident. The very nomenclatures of biology presuppose this. Relativity reigns supreme in biology. But not only is this so: the relationships of life also actively assert and maintain themselves. The responses of the nervous system become intelligible from this point of view; but this is still more evident in connexion with the simpler responses within the body to molecular stimuli—the responses connected with respiratory exchange, assimilation and secretion. It is with these responses that my own experimental work has been mainly associated, and the study of them has left no doubt in my mind of the necessity for regarding the already defined conception of life itself as fundamental in biology.

Perhaps this necessity will become more easy to understand if I refer to the basis of practical medicine in its therapeutical side. When the organism is injured by any passing cause, tissues of exquisite delicacy have been destroyed or altered in structure. We have no means of repairing or replacing these structures as we might repair or replace the injured parts of a machine. Nevertheless, the injuries can be healed, and by various means we can facilitate the process or render it certain. It is because life actively maintains and reproduces its normals that recovery is brought about. What a doctor does is merely to aid Nature in the process. Any other view of the matter amounts to mere quackery which has been repudiated by scientific medicine ever since the time of Hippocrates.

But I can almost hear some well-meaning scientific colleague saying "Your conception of life may be all very well as a sort of heuristic principle, but it is totally unintelligible. The process of healing and reproduction must depend on a series of molecular reactions; and the right way to understand it is to investigate these reactions one by one. Since the living body is material it must be subject to the laws of all material action. In other words, it must be a mechanism, though a very finely balanced and complex molecular mechanism." Let us then suppose for the moment that this is so, and see how the assumption works out.

The living body reproduces itself from generation to generation. In the process of reproduction it grows from a microscopical speck, or rather two microscopical specks, the male and female elements, which have united to form one. Little or none of the assumed molecular machinery can exist in these specks: it must all be gradually built up again in the course of development. This development itself is a very complex process, which on the mechanistic theory would necessitate the existence of extraordinarily complex molecular machinery in the germinal specks, and corresponding machinery in the parent organisms for producing the germinal machinery. The mind recoils from the incredible complications involved.

Specific germinal cells in the bodies of animals can sometimes be followed in their successive divisions from one generation to another, and in this sense there is continuity of the germ-plasm. On the mechanistic theory, therefore, the molecular machinery of reproduction reproduces itself by fission from its like. But how is a delicate piece of machinery to reproduce itself by fission? Imagine the unspeakable confusion in such a process, or in the sexual union of two similar pieces of machinery!

I have perhaps said enough to show why I cannot regard the mechanistic theory of life as tenable. It involves quite impossible assumptions and leads us nowhere in respect of the characteristic phenomena of life. Not only the newspapers, but also scientific men, continue to speak of the mechanism of life and heredity: I confess that such an expression has no meaning whatsoever to me. We cannot dispense with the distinctive conception of life. Let there be no mistake, however, about what this implies. It implies that the old conception of visible reality which Galileo and Newton set forth has broken down; and that there is no use in appealing to that conception in support of a mechanistic theory of life. Life would be unintelligible on that conception; but it is reality that science has to deal with, and not an ideal world of mechanism. The ideal mechanical world of Galileo and Newton corresponds sufficiently well for most practical purposes with our experience of inorganic phenomena, but does not correspond with our experience of biological phenomena. The supposed self-existent bodies and separable reactions of the ideal mechanical world have turned out to be not really self-existent and separable; and we have to modify our fundamental conception of visible reality accordingly, though for many practical purposes the merely mechanical conception may suffice.

It may be many years before the significance of the phenomena of life for our conceptions of visible reality is generally understood; but assuredly this general understanding will in time be reached.

So far I have only discussed life in such a form as we seem to meet with in plants, or in the activities of parts of our own bodies which we assume to be unconscious. I now come to conscious activity. We know what conscious action is in ourselves, and we can easily infer its presence or apparent absence in other persons. We can also form some judgment as to its presence in even lowly organised animals.

Conscious is distinguished from unconscious experience or activity by the fact that a conscious experience or action carries with it an ordered reference to both past and anticipated experiences, as well as to other present experiences. It was Kant who first pointed out this fundamental fact clearly in relation to perception. A conscious experience not carrying in itself ordered relations to past and anticipated experience is a purely imaginary figment. This discovery constitutes the great advance which Kant made beyond Berkeley and Hume. We cannot derive our conceptions of the spatial and temporal orderliness of our world from separate experiences of it: the orderliness is already given in any experience, and belongs to it. An ordered universe existing apart from conscious experience of it would be nothing to us. It was to a world of relativity that Kant's analysis of perception led.

At first sight Kant's idealism seems to lead us into impossible or practically unmeaning conclusions; but let us follow the same line of reasoning further than

Kant followed it. He belonged to his own time. The order which he found to be implied in conscious experience was simply the order of the physical world as pictured by Galileo and Newton; and indeed his idealistic philosophy became a sort of buttress to their ideas of visible reality. Whether visible reality was self-existent, or relative, or ideal did not seem to matter much in practice, although with relativity physics Kant's reasoning has now come into prominence among physicists themselves.

When we examine our own conscious experiences and actions we find that they hang together in another manner besides those pointed out by Kant. They hang together or are essentially related in the manner already described in connexion with the phenomena of life. Whether we will or no, they influence and inhibit one another in a manner which cannot be predicted or understood on merely physical principles, and which only becomes more or less predictable or intelligible in the light of the conception of life. What Locke called the secondary qualities in experience come under this category, together with various natural appetites and instincts, repulsions and attractions. Into all our conscious perceptions and actions this element of relatedness enters, and not merely the relatedness in a physical sense, to which Kant directed attention. Both in connexion with ourselves and with other organisms is this true. It is only by a process of artificial abstraction that we can neglect the biological aspect of our conscious experience, and the neglect of this aspect has led to endless intellectual confusion.

We must not make the mistake of supposing that the conception of life stops short at the body-surface of an organism. A living organism cannot be separated in thought from its environment. In life the physiological relation to environment is maintained just as clearly as the physiological relation between the parts of the body. An organism belongs to its environment just as much as its parts belong to one another. Different individual organisms are also organically related to one another, by parenthood, sex relations, and mutual association of various kinds. The normal limits in duration of individual life are also an apparent evidence of this relationship.

In consciousness of the biological aspect of experience, and in corresponding conscious action, our lives have for us a past and future which is inseparable from the present. Our perceptions and actions are thus those of conscious interest, as distinguished from the blind immediacy of what we regard as mere biological phenomena. Our world is a world of interests and values, and our actions have a corresponding responsibility attached to them.

The existence of biological phenomena showed us that a mere mechanical conception of visible reality is fundamentally inadequate, however useful practically for some purposes. The progress of philosophical investigation since Descartes has also shown us that in whatever way we may for temporary practical purposes represent to ourselves the visible universe, it cannot be in reality anything but a universe of conscious existence. Berkeley, Hume, Kant, and their lineal successors have been in agreement about this, however short they may have stopped in the further development of their conclusion. Putting together this conclusion with the previous one, we find that our universe is a univ of perceived interests and values, and of responsi conduct.

Let us now examine further the nature of the intere and values which present themselves in perception a conscious behaviour. We can think of them in the fi place as the interests of an individual human organis In the life of a conscious organism, what is required the maintenance of its normal organic life and struct is foreseen and provided for in the light of past exp ence, since conscious experience and action reach o as Kant showed, into both the past and the future. this process the environment is as much concern as the body of the organism itself, since life, when investigate it, involves, and indeed manifests itself a normal relation between living organic structure a environment. This fact is to some extent masked higher organisms, which, as Claude Bernard first in cated, possess, in the form of their blood, an inter environment which by various means is kept amazing constant in its character, and acts as a sort of buf between the living tissues and the variations in t external environment; but now that physiologists ha become aware of this, the true relations betwe organisms and environment are standing out ever m clearly. It is a relationship which can only be comp hended as an organic one: a merely physical interp tation of it is not possible. Even from the point f view of our merely individual lives, our environment in no mere physical relationship to us: it is bone of c bone and flesh of our flesh.

An isolated individual human organism is, howev only a scientific abstraction: for without at least mother or nurse no human infant could survive. In t perception more particularly of human relationshi and corresponding actions, we become aware of wi interests than those centred round our individ organisms. The wider interests centre round fam countrymen, the human race, and extend also animals, plants, and country. They extend also both the past and future. In the experiencing of the it is just reality itself that is being revealed to us; a spiritual reality, not merely ideal scientific abstractio We are, in fact, no mere self-centred beings, comple in ourselves; and those who set before themselves, a endeavour to act on, the idea that they are entire self-centred are only doing violence to their own natu

This latter conclusion seems to me equally cle even if we simply regard human behaviour from abstract biological point of view. A higher organism an assemblage of countless individual cells; but t behaviour of not one of them is intelligible biological apart from its relations to the rest, and to the enviro ment generally. In exactly the same way the biologic behaviour of individual human organisms is unintel gible apart from their relations to other hum organisms and the rest of their environment. The very being in the biological sense manifests itself this relationship. We belong in the most intima sense to our environment.

The wider interests which reveal themselves in huma society have a compelling power which dominates wh we regard as mere individual interests. In these wid interests we meet with something which we can in th sense describe as "not ourselves," though in anoth

ense it is the reality of ourselves. It binds us together spirit, so that what others feel and see we also feel nd see. We thus attain to what we regard as objective perception, a perception that others share in, and nat unites all men: also to corresponding objective tandards of behaviour.

This perception and behaviour is not just the collective or average perception and behaviour of a number f individuals, but something which only shows itself n fellowship with others, and in the contemplation of ur relationship with Nature. It is the manifestation f the spiritual Reality of our universe—the Reality which men call God.

We are so accustomed to regard reality as physical eality in the sense of Galileo and Newton that any more dequate conception of reality seems to us far away and nreal—mere mysticism. We are the children of a naterialistic age. We look for a soul consisting, if not f ordinary matter in the mechanical sense, yet of omething which is only a thinly veiled imitation of it. We look, also, for a similarly constituted God. Such ntities can never be found. God is with us, in us, and verywhere around us, as Jesus taught. We must earn to see spiritual reality, and not the mere appearnces of matter. We must learn, also, that the voice f God is not a voice threatening us from outside with naterial punishments or coaxing us with the hope of naterial rewards, but a voice which, when we hear it, ransforms our most hidden motives and thoughts.

Let me return to the relations of biology and other branches of natural science to religion. Perhaps it might seem that what I have been saying attributes to natural science the responsibility of blinding us to spiritual reality. Are not, for example, Galileo and Newton, and the great biologists who have treated the living body as if it were a piece of mechanism, responsible in this respect? To point out that theologians are equally responsible does not answer this question. I wish to consider it directly.

When we examine the original contributions of great men of science we always find, first, that on the data before them their conclusions were justified, and, secondly, that these conclusions were calculated to be of great practical use to their fellow men. If it is true that the reality of our universe is spiritual, it is no less true that we are constantly struggling with illusion and imperfection, and that it is only in that struggle that spiritual reality manifests itself to us. We cannot separate faith from works. The motive of science has always been the discovery of what, in one way or another, will be of use; and at every turn we make use of scientific discovery in practical affairs. It does not matter how limited in scope the discovery may be, we can always make use of it. To take examples, the discoveries by Kepler of the mechanism by which images are focussed on the retina, or by Harvey of a mechanical process by which blood is circulated through the body, were limited in scope, but of immense practical service. The eye cannot be regarded as a mere mechanical structure, nor the circulation as a mere mechanical process, so there is a reality beyond these discoveries. This does not, however, detract from their value, any more than the discoveries of Einstein have detracted from the value of Newton's discoveries.

Scientific investigation is just part of the struggle in which spiritual reality manifests itself; and the realisation of this brings science, particularly pure science, very near to religion. It is only when science becomes dogmatic that it assumes an attitude which seems to deny the existence of spiritual reality. We find very little of this dogmatism in the writings of great men of science, but much more of it in the desiccated science of systematic text-books and popular expositions. For example, the idea is spread abroad in such writings that natural science, unlike philosophy, advances by a steady process of addition. We have only to look back on the history of natural science to see how utterly misleading this idea is. The progress of science is just as much strown with the remnants of discarded theories as is the progress of philosophy; but, in spite of this, continuity of development is evident in the histories of both of these subjects. Surely it must be the same with theology.

During most of my life I have been struggling more or less with scientific dogmatism, but I have never before addressed an audience mainly clerical. I wish to take the opportunity, therefore, of adding my voice to those of others who are engaged in struggling with the shackles of theological dogmatism. There are very many who, like myself, are kept away from existing churches by creeds and church services which they cannot honestly countenance, and perhaps a still larger number who are actively hostile because they regard churches as hotbeds of superstition. If I thought that my country could get on equally well without churches I should not care what was taught in them. But I do not think so. We need to be constantly reminded of that spiritual reality which manifests itself in willing service of every kind, and without the perception of which our country would relapse into chaos.

The churches cannot afford to be hampered by unintelligible beliefs which are mainly materialistic accretions of Christianity and greatly weaken its influence on those who are worth influencing. Religion itself stands on ground which cannot be assailed: it has no use for rickety defences. The story of Jesus and His teaching appeals to all men, and influences them practically, because it touches what is deepest and most real in them. Many, however, feel forced to conclude that that teaching was based only on emotional illusion. Hence adequate philosophical or theological support is needed for it. This support should be based on the widest philosophical and scientific knowledge. Any shirking of the questions involved, or cowardly sheltering behind mere traditional authority, is fatal. The true function of a church is to help men to see reality as a whole, and to guide their actions accordingly, thus preventing social chaos, intellectual confusion, and artistic decay.

You are members of the national Church of England, and we are meeting near the spot where one of the greatest leaders of that Church, a man of English yeoman stock, met his end. It is to Latimer that my mind goes back when I appeal for intellectual freedom in the English Church. He stood, not only for social justice and humanity in his country, but also for intellectual freedom. It was not of his own sufferings, or his own soul, that he spoke as he was dying, but of the England he had served so fearlessly, so lovingly, so faithfully, thus finding oneness with God.

The candle which was lighted in England as Latimer and Ridley perished is still burning.

The Forces which lift Aeroplanes.[1]

By Prof. V. K. F. Bjerknes, Geophysical Institute, Bergen.

THE forces which carry aeroplanes are now subject to intensive experimental and theoretical investigation. In one respect, however, these investigations have led to a surprising result, namely, that the force which makes flying possible belongs to a group of forces discovered long ago, before the period of aviation. Their existence had been predicted mathematically, and these predictions had been verified by experiments.

The Direct Geometric and the Inverse Dynamic Analogy between Hydrodynamic and Electromagnetic Fields.

This old theory, and these old experiments, relate to what is called *hydrodynamic actions-at-a-distance*. The period when the doctrine of action-at-a-distance was absolutely predominant lasted, at least on the Continent, until about thirty years ago. The researches which I am about to describe, date from that period. My father, C. A. Bjerknes, could not reconcile himself with this doctrine at the time when he was a student at the University of Christiania, about eighty years ago. Ten years later he had the opportunity of acquainting himself with recent results of research in theoretical hydrodynamics. These had just led to a surprising fact: a spherical body could move through a frictionless fluid without experiencing any resistance. This paradox was in his eyes an important fact in discussing action-at-a-distance. The doctrine of Newtonianists had been that space was empty. They believed that a medium filling it would ultimately stop every motion. But this argument now turned out to be erroneous. The supposition that space was filled with a medium was not contradictory to the first axiom of dynamics, the principle of inertia. This made another idea occur to him: Should not the same medium be able also to propagate actions from body to body, thus giving rise to apparent action-at-a-distance? And would not the answer be found by solving the problem of simultaneous motion of two or more bodies in the fluid—for mathematical simplicity of spherical or cylindrical form?

The conditions under which my father worked were not favourable. But he never gave up his point of view, and twenty-five years later he was in possession of the full solution of the problem, and had verified the results by a series of striking experiments.

The result was that a very remarkable analogy became evident between the field of motion in a fluid and the electric or magnetic field of force: the bodies produced fields of motion of precisely the same geometric structure as static or stationary electric or magnetic fields. Moreover, they exert apparent actions-at-a-distance upon each other, equal to, but—most curiously—opposite to the actions-at-a-distance between the corresponding bodies in the electric or magnetic fields.

General Statement of the Analogy.

In one respect, however, my father's theory was special: he had proved this analogy to exist only for bodies of spherical or cylindrical form. By slightly changing the problem, I succeeded some twenty years ago in giving an absolutely general proof of the analog I retained in my theory the idea that the main fluid w homogeneous and incompressible. But for the sol spheres and cylinders I substituted *fluid* bodies of ar shape. These bodies may differ from the surroundin fluid in four respects: (1) In density: this gives th body a reaction against acceleration, different from tha of the surrounding fluid; (2) in compressibility: th bodies may perform motions of expansion and co traction; (3) the motion considered was allowed to b vortical inside the bodies, while it was always irrot tional in the surrounding fluid; (4) external force ma act upon the elements of the bodies but not on those the surrounding fluid.

The advantage of considering the entire system a fluid is that its dynamics are then determined com pletely by the hydrodynamic equations. Therefo the analogy to the electric or magnetic field may b demonstrated by a simple—in reality very simple—transformation of these equations. The leading ide of this transformation is to consider the actual flui field of motion as made up by two partial fields: th *impressed field*, which is that produced by extern force, including the hydrodynamic actions-at-a-distance and the *induced* or *free field*, which is due to flui pressure, setting aside that part of the pressure whic produces the hydrodynamic actions-at-a-distanc The impressed field exists only inside the bodies, whil the induced or free field pervades all space, includin that inside the bodies, and when added to the impresse field in this inside space, it gives the actual fields c motion of the bodies.

This system can be compared with an electric o magnetic one. Specific volume will then correspon to magnetic permeability or specific inductive capacity velocity will correspond to magnetic induction o electric displacement. The product of velocity int density, that is, specific momentum, will correspond t magnetic or electric intensity. Impressed field withi the fluid bodies will correspond to impressed field in th interior of a permanent magnet or a pyro-electri crystal, and induced hydrodynamical field will corre spond to induced magnetic or electric field in externa as well as in internal space. Velocity of expansion o of contraction will correspond to magnetic or electri charge, positive or negative; and vorticity, specially defined here to be the curl of induced specific momentum will correspond to electric current density.

This correspondence between the quantities used fo describing the two kinds of fields being agreed upon the analogy between the two kinds of fields may b stated thus:

At any moment the field of motion of the fluid systen is identical in geometrical structure with a certain stati or stationary magnetic or electric field; and in thi hydrodynamic field there are apparent actions-at-a distance which, element for element, are equal but opposit to those of the corresponding forces of the magnetic o electric field.

Having obtained this theoretical result we can easily apply it to solid bodies; for the external force which w have introduced is subject to no restriction. We can

[1] From a discourse delivered at the Royal Institution on Friday, May 9.

herefore let this force, or a certain part of it, control he motion of a body in such a way that it moves as if it were rigid, or solidly elastic. This result is attained by imagining reciprocal actions between the particles of the body which have no resultant for the entire body. The only thing to be taken into account will be the impressed fields produced by these reciprocal actions between the particles. But as these fields are characterised by small motions in all possible directions, they will in general give rise only to insignificant reactions with the exterior field.

By substituting solid bodies for the fluid bodies we can obtain experimental demonstrations. But, it may be argued, where solid bodies are moving in a fluid we do not in general observe any striking analogy with the phenomena of the electric or magnetic fields. The reason for this is twofold. First, to recognise the analogy we must divide the field into its impressed and induced parts. The distinction between these two partial fields will not in general be visible to the eye. It must be found by a dynamical analysis. Secondly, the hydrodynamic system is a moving system which is always changing its configuration, and the direction and intensity of motion of its different parts. During each new phase of its motion we must therefore compare it with a new electromagnetic system: this gives a fugitive character to the analogy. But in two cases it must crystallise into a concrete and strikingly visible form: first, when the motion is permanent, and secondly, when it consists of small synchronous oscillations about an invariable average configuration. In both cases we have to compare it with a constant electric or magnetic field. In both cases the induced hydrodynamic field is hidden as a more or less invisible field, while that part of the impressed field which is due to the hydrodynamic actions-at-a-distance produces strikingly visible effects.

This result is, however, obtained in both cases at the expense of a certain reduction of the extent of the analogy. As vortices cannot be oscillatory in a frictionless fluid, they must be zero. In the oscillating case, therefore, the analogy with the electric currents fails. On the other hand, as displacement of the boundary surface would violate the permanence of the motion, all phenomena due to change of volume or of place of the bodies drop out; and we retain only the phenomena depending upon permanent circulation, corresponding to those of electric currents.

The Instruments.

A general auxiliary instrument is a generator for producing vibrating motion. A little electric motor drives a spindle having two eccentrics, each of which works a little pump. Each pump is double-acting and consists simply of cylinder and piston but has no valves. Through the outlet tubes communicating with the ends of the cylinders a few cubic centimetres of air is thus alternately driven out and in, in opposite phases from the two ends of the same cylinder. A cock allows us to regulate the amplitude of that oscillating air current which is conveyed to the main instruments. When a unidirectional air current is desired, a simple valve arrangement may easily be inserted.

A practical peculiarity of the instrument is that the cylinders, not the pistons, are connected with the eccentrics, and that the pistons react against the motion only by their inertia. This proves useful in connexion with the regulation of the amplitudes. Cylinder and piston are carefully polished but *never* oiled. Another peculiarity of construction is an elaborate symmetry of the moving masses and of their motions, in order to eliminate all vibration of the instrument by compensation.

The alternating air currents from the generator are used to produce two kinds of vibration: first, pulsations, or periodic changes of volume, and secondly, oscillations or periodic changes of place. The pulsating body is a drum having metallic membranes (by their durability preferable to indiarubber membranes) and fixed on the end of a metal tube (Fig. 1, I, II). The membranes are alternately blown out and sucked together by the alternating air current. Loading one membrane of such a pulsator, and connecting the other membrane with a spherical shell, which is mounted on a tube and surrounds the pulsator, we get an oscillator (Fig. 1, III): the outer shell and the inner load make opposite oscillations. The desirable case when these become equal amplitudes is attained when the weight of the load equals the sum of the weight of the spherical shell and the half of the mass of water displaced by it. In this event the pulsator will, by the principle of the conservation of the centre of gravity, remain at rest, and the outer shell will oscillate undisturbed both when the projecting tube of the pulsator is taken in the hand and when it is inserted in a rigid clamp. It will not transfer disturbing oscillations to sensitive balances in which it is inserted for the experiments.

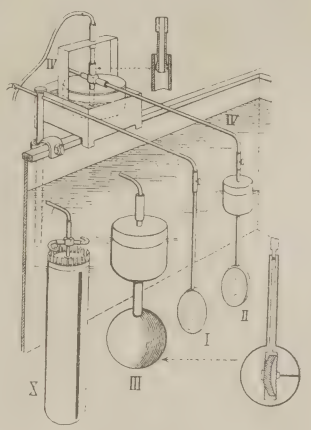

Fig. 1.—Balance arrangement with pulsators (I, II), oscillator (III), rotating cylinder (X).

Different arrangements can be made for giving such a pulsator or oscillator the degree of mobility required for examining the forces or couples exerted upon them. It is generally convenient to let it float with a buoy. If then the tube conveying the air from the generator is sufficiently flexible, we have at once both translatory and rotatory mobility. To reduce the mobility to a pure translational one, we may give the system of tubes which convey the air from the generator the form of a torsion balance. The weight of this balance is conveniently carried by a floating buoy, swimming in the tank used for the experiments, or in an extra vessel outside it, to reserve the main tank exclusively for the bodies under experiment. We may also do away with the torsion tube of this balance, and let the air go directly from a fixed tube through a loose joint into the balance with really very little loss of air (Fig. 1, IV). This has the advantage that the equilibrium is always indifferent. One of these balance arrangements may be used for demonstrating the attractions, repulsions,

or lateral displacements exerted upon a pulsating or an oscillating body. The latter may be inserted in the balance in two principal ways: for longitudinal mobility, so that its direction of mobility coincides with its axis of oscillations; or for transverse mobility, so that the direction of its mobility is normal to its axis of oscillation. Rotational mobility of an oscillator is obtained either by suspending it by a rubber tube, or by letting the air pass direct into the floating oscillator through a loose joint.

As bodies having no vibrating motion of their own, we use a heavy sphere suspended from a float, a light sphere held under water by a load and suspended from a float, a light and heavy cylinder suspended in the same way.

Finally, for studying the field of motion set up in the fluid we may use a simple arrangement, namely, a light spherical body attached to an elastic wire. This sphere will be set into induced oscillations by the surrounding fluid, and, choosing that period which gives resonance, we can magnify the minute water oscillations and mal them visible. The sphere may also carry a light r which projects above the surface of the water, ar carries a pencil which inscribes its oscillations aut matically with ink upon a glass plate placed above t water.

These instruments serve for experiments wit vibrating bodies. Permanent motions can be produce by the rotation of cylindrical bodies. By a simp valve arrangement inserted in the tubes conveying t air current from the generator, the alternating curre may be changed into a unidirectional one. Th current can then be used to drive a turbine attached t a cylinder which is thus set into rotation (Fig. 1, X). T examine the forces exerted upon such a cylinder th latter is placed in the balance just as the pulsator o oscillator was, while another cylinder driven in th same way is mounted on a handle which may be take in the hand or fixed in a support.

(*To be continued.*)

Obituary.

Sir William Bayliss, F.R.S.

"BAYLISS'S book is by far his greatest contribution to science—much more important than any of his individual discoveries is his statement of his point of view." These were substantially the words used to me by a very competent critic. At the time I wondered whether or not it were so, and I have often wondered since. Bayliss's investigations into the electric phenomena of the heart [1] and the salivary glands,[2] into the conditions which govern the cerebral circulation,[3] into the muscular movements of the alimentary canal,[4] into the mechanism of vaso-dilatation,[5] into the correlation of vaso-motor reflexes;[6] his establishment of the existence of antidromic fibres in the mammal,[7] his researches on the application of surface phenomena to physiological action,[8] and the discovery of secretion [9]—these were his principal discoveries.

When all allowance has been made for the fact that most of this work was carried out in collaboration, it remains an extraordinary tribute to a man's point of view to say that the statement of it transcends such researches. Yet in support of my friend's statement I reflect that in another continent there are "Bayliss Clubs"; these do not exist for the study of the specific subjects enumerated, but for the joint discussion by physiologists and chemists of so much of science as they have in common. The association of Bayliss's name with such societies is a tribute precisely to Bayliss's statement of his point. It is not merely that when one asked why the clubs were so called one received the answer, "We discuss the sort of thing which is in Bayliss's book," but that when one comes to think the matter out, one finds it not a little surprising that such societies were not associated with other names; for it cannot be claimed that Bayliss was a pioneer in the investigation of biochemistry.

[1] *Journ. of Physiol.* 12. xx, 1891, and 13. lviii, 1891.
[2] *Journ. of Physiol.* 7. 217, 1886.
[3] *Journ. of Physiol.* 18. 334, 1895.
[4] *Journ. of Physiol.* 24. 99, 1899.
[5] *Journ. of Physiol.* 16. 10, 1894, and 24. 173, 1901.
[6] *Journ. of Physiol.* 37. 264, 1908.
[7] *Journ. of Physiol.* 38. 276, 1902.
[8] Proc. Roy. Soc. B, 84. 229, 1911, and 91. 196, 1920.
[9] *Journ. of Physiol.* 28. 325, 1902, and 29. 174, 1903.

His interest in the subject—so far as may be gleane from his published works—dated from about the com mencement of this century—before which date th pioneer work in Great Britain had been done. Hard had launched colloid chemistry in the 'nineties Hopkins, before the eighteen hundreds were complete was well forward with that series of isolations whic adorn both organic chemistry and physiological science and Halliburton had done the major portion of hi work.

Bayliss's great contribution was that he discusse the whole subject of biochemistry as a continuou whole, thinking out each point *ab initio*, and com mitting the record to paper, so that what he though for himself he thought also for others. His method o approaching a subject was one which lent itself admir ably to this procedure. The quality of genius differs from individual to individual, probably even more tha its quantity. Among scientific men, the genius of som is of the artistic type; though possessing great cer tainty of touch their inspiration comes they know no whence. To the onlooker it appears almost to be ar accident; that it is not so is proved by the fact tha it crops out too often in the life of the same person In others genius is of the mathematical type; with them the premises are grouped in a particular way and in their vision the conclusion flashes out.

Bayliss's genius was not precisely of either type—at least if my own appreciation of it may be trusted. He took nothing for granted, he inquired with meticulous care into every step of an argument; if he found some thing which was not perfectly clear to him, he spared no pains to discover whether the thread of the argu ment was really broken or whether he had merely failed to follow it. In the end his mind became clear on the subject; to his own satisfaction he was able to pronounce either that he understood the matter and that it was thus, or that he failed to understand it because the thread, to the best of his judgment, was not continuous.

Such a method is eminently calculated to exclude all forms of obscurantism, and indeed nothing was more

reign to Bayliss's philosophy than vague talk about vital force" or the like. Either a phenomenon was derstood, in which case the explanation could be itten down and placed on record in his book, or it mained for investigation. In the latter case it might ll into one of two categories, (*a*) that of being capable explanation on the basis of current knowledge of the operties of matter, (*b*) that which awaited further scoveries into the fundamental conditions which vern material things. It was Bayliss's good fortune be at the zenith of his intellectual powers at a time hen important additions were made to the knowledge several departments of chemistry and physics, such, r example, as of adsorption, of catalytic action, of terfacial phenomena, and of radiant energy. Each ccessive addition afforded to Bayliss a prospect of e removal of phenomena from category (*b*) (above) to tegory (*a*), and of their final elimination from the gion of the unexplained. That was Bayliss's point of ew—as I understand the matter; it was a point of ew extremely stimulating to the student, not only ecause it led so directly to experimental investigaon, but also because it led along a road which emed so straight and so easy to follow.

Could Bayliss have been given the choice as between spectacular form of genius on one hand and a form hich was readily intelligible on the other, I feel sure e would have chosen the latter. The spectacular had ttle attraction for him; simplicity was characteristic less of his intellectual outlook than of his personal abits.

I gladly concede to rising generations that to them ayliss's statement of his point of view is his most nportant work, but to myself Bayliss—of course in onjunction with Starling—was pre-eminently the iscoverer of secretion. The moment when the first rop of pancreatic juice was elicited by the injection of uodenal extract must, I think, have been the most ramatic in his scientific career. Possibly I take this iew, because I was at a peculiarly impressionable age t the time, possibly it is accentuated because of a rifling incident which stamps it upon my mind. I had he good fortune to witness, not indeed the first successul experiment on the subject, but I think the second —that in which the first was to be either confirmed or efuted. The physiological laboratory at University ollege, London, was in those days peculiarly open to oung physiologists—I imagine that it is not less so iow. Some errand took me round there: the door of Bayliss and Starling's room was open: an experiment vas in progress. Bayliss held a flask in one hand, and vith the other was in the act of introducing a tissue xtract into the circulation from a burette, Starling was n his haunches, his eye on the level of a canula which rojected from the animal: the extract went in: the lood pressure fell for the nonce: there was a pause and hen—drop, drop, drop from the canula. There was no ecrecy—all was explained without reserve, to a man vho had published perhaps a couple of papers, vho hailed from another laboratory, whose very resence might have been accounted an intrusion, and vho had no possible claim on either the confidence or he genius of those who had made so great a discovery. Thus can generosity and understanding attract youth within the charmed circle of genius.

Indeed, Bayliss loved the company of young. I can see him now discussing some topic with a circle of young people, and, it may be, obscure physiologists, at the meeting of some society, and by his simplicity and sympathy wiping out the disparity in age and status, or lunching off porridge in a popular restaurant surrounded by young researchers and wishing for no better fare and no better company.

Bayliss took a considerable interest in public affairs —scientific, sociological, and political—probably in that order. Under this heading mention should first be made of his work in connexion with the Medical Research Council; for the following information I am indebted to Sir Walter Fletcher. From the historical point of view the Medical Research Council came into being at a time when the practise of medicine in Great Britain had much to gain from a closer liaison with physiological discovery—a fact which was greatly emphasised by the War, and one which afforded to Bayliss a field of peculiar usefulness in connexion with the work of the Council. The work which Bayliss did during the War will always associate his name with the subject of surgical shock, for the fuller understanding of which the Council appointed a very strong committee over which Bayliss presided; his own contribution was principally on the side of treatment. His introduction of intravenous injections of gum saline not only was regarded by many competent authorities as being of great use, but also it paved the way for a renewed interest in blood transfusion and a much improved technique for the purpose.

After the War, Bayliss assisted the Medical Research Council by presiding over a Committee for the investigation of the biological action of light, the object of "which is to analyse, explain, and extend all our valuable but still quite empirical knowledge of the action of light on the body, as in increasing its defence against tuberculosis, raising the bacteriological power of the blood, and in replacing and facilitating the action of vitamin A." Bayliss greatly assisted in suggesting precise laboratory observations. This work is still in progress, and in its concluding phases his loss will be greatly felt.

Much of Bayliss's work was of a surgical type; and, probably rather by accident, he was singled out at one time as the special target of those who disapproved of animal experimentation—a rather singular irony, because he was always on the side of the weak, the struggling, and the oppressed in all movements designed to better their condition. In politics he was a Liberal and presided over a local organisation of the Liberal party.

Bayliss's sociological interests became more evident towards the end of his life. The last man to derive any satisfaction from seeing his name in print, he was a frequent contributor to the press in the form of letters on such subjects as he thought might be helpful. This was part of his "statement of his point of view," though in a minor sphere; where he found difficulties he recorded them and gave the record to all and sundry who might be helped by it. On scientific matters he was a frequent contributor to NATURE, whilst his sociological writings embraced subjects so widely separated as the importation of cocaine, the methods of killing meat for food, and the desirability of birth

control. Indeed, he was a vice-president of the Society for Constructive Birth Control and Racial Progress.

Bayliss received the honour of knighthood in 1922. He held the following degrees and distinctions: M.A. and D.Sc. (Oxon.), Hon. LL.D. (Aberdeen and St. Andrews), F.R.S., Hon. Fellow of Wadham College, Oxford, Hon. member of the Danish Academy of Science, Corresponding Member of the Société de Biologie (Paris) and of the Royal Academy of Belgium, Professor of General Physiology, University College, London, member of the Council of the Royal Society, 1913–1915, secretary and afterwards treasurer of the Physiological Society, Joint Editor of *Physiological Abstracts* and of the *Biochemical Journal*. Bayliss, with Starling, delivered the Croonian Lecture to the Royal Society in 1904 and received the Royal Medal in 1911, the Copley Medal in 1919, and the Baly Medal of the Royal College of Physicians in 1917. He delivered the Oliver-Sharpey Lectures in 1918, the Sylvanus Thompson Lectures in 1919, and the Herter Lectures in 1922. JOSEPH BARCROFT.

AN appreciative account of the scientific career and work of Dr. T. C. Mendenhall, who died on March 22, is contributed to *Science* of July 11 by Mr. G. R. Putnam, and we are indebted to it for the following particulars: Dr. Mendenhall was born on October 4, 1841, and after preliminary training as a teacher, became the first professor of physics in the Ohio State University. He went to Japan in 1878 as professor of physics in the Imperial University at Tokyo, and three years later returned to Ohio. He was preside for several years of the Rose Polytechnic Institu and for seven years of the Worcester Polytech Institute, from which he retired in 1901. Dr. Mend hall took a leading part in many activities connect with science and engineering in the United Stat He was for five years superintendent of the Coast a Geodetic Survey, and served as president of t American Association for the Advancement of Scien and the American Metrological Society. He carri out some notable investigations in terrestrial gravit seismology, atmospheric electricity, and related subject

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WE regret to announce the following deaths:

Mr. F. H. Bradley, O.M., fellow of Merton Colleg Oxford, and author of "Appearance and Reality "Principles of Logic," and other authoritative wor on problems of philosophy, on September 18, ag seventy-eight.

Prof. Alexander Darroch, professor of education the University of Edinburgh, aged sixty-one.

Dr. Franz Doflein, emeritus professor of zoolo and comparative anatomy in the University of Breslau on August 26, aged fifty-one.

Dr. J. Elliott Gilpin, professor of chemistry Johns Hopkins University, known for his work on t action of chlorides of phosphorus on amides and c fractionation by capillary diffusion of crude petroleu aged fifty-seven.

Dr. Sidney Martin, F.R.S., physician to Universi College Hospital, London, and distinguished r researches in chemical physiology and pathology, September 22, aged sixty-four.

Current Topics and Events.

A FINE, seated statue of Lord Lister, in academic robes, the work of Mr. G. H. Paulin, was unveiled in Kelvingrove Park, Glasgow, adjoining the University, on September 17, by Sir Hector C. Cameron, Dean of Faculties. The Lord Provost presided, and speeches setting forth Lord Lister's unique service to humanity in the domain of scientific surgery were made by Sir Hector, Sir Donald MacAlister, Bt., principal of the University and president of the General Medical Council, and Prof. J. H. Teacher, of the Royal Infirmary Department of Pathology, who is the custodian of the Lister relics there preserved. It was in the Kelvingrove Park, near his house, that Lister meditated the principles of his antiseptic method of wound treatment, during his tenure of the University chair of surgery from 1860 until 1869. It was in the Royal Infirmary, near the old College, that he applied these principles to practice, and thereby demonstrated their efficacy in the prevention of suppuration and of septic poisoning in operative wounds. The ceremony was preceded by a luncheon in the Civic Chambers, attended by a large number of distinguished surgeons and citizens of Glasgow, and by Mr. J. J. Lister, fellow of St. John's College, Cambridge, and nephew of Lord Lister. The latter spoke of his uncle's early researches, and of his private life, in response to the toast of the Lister family, proposed by Sir Donald MacAlister, who narrated some picturesque incidents of his friendsh with Lord Lister during thirty years. The stat completes the effort begun by the Glasgow List Memorial Committee in 1912, but interrupted by t War. Generous contributions have been made by i not only to the Glasgow monument, but also to t international fund for establishing a Lister Oratic and Prize for research in surgery, to the memorial Westminster Abbey, and to the Lister collectio displayed in the Glasgow Royal Infirmary in con memoration of the great surgeon's association wi the institution.

THE announcement in the daily press regarding t decision of the Government to provide a "further sum of 500,000*l.* for agricultural education an research deserves, perhaps, some elucidation. It ma be recalled that the Development Commissione hold two funds—the old and the new. From the ol come such charges as the grants to the variou Agricultural Research Institutes established befo the War and the salaries and expenses of the advisor officers attached to University Agricultural Depar ments. The old fund, also, has to meet the cost what may be termed the miscellaneous statutor activities of the Commissioners in relation to fishery harbours, etc. To the new fund, on the other hand being the creation of the Corn Production (Repea

ct, is debited the cost (in England and Wales only) certain schemes which escaped the fall of the eddes axe. As to finance, it would appear that the d fund is kept alive by annual doles from the reasury, whereas the new fund, starting with 30,000*l.* in 1921, has now received a windfall of a rther sum of 500,000*l.* In a communiqué recently sued by the Ministry, it is announced that the new oney will probably be allocated in part to the hemes relating to research on foot and mouth sease; economic research; marketing investigaons; veterinary education and research; soil rveys; and the National Institute of Agricultural otany. It is also announced that, in relation to the ew money, no definite allocation of funds as between cotland and England has been made. From this xplanation it would appear that the Corn Production New" Fund of 850,000*l.* is earmarked for expenditure England and Wales only.

ANNOUNCEMENT has been made of the retirement n September 30 of Dr. Crichton Mitchell from the rvice of the Meteorological Office, in which he has cted for some years as general superintendent of ne activities of the office in Scotland. He was riginally appointed from May 16, 1916, to be uperintendent of the Observatory at Eskdalemuir, n the recommendation of the Gassiot Committee of ne Royal Society. That committee is responsible or the administration of the Gassiot Trust Fund, the ost notable of the few private endowments for eophysical subjects in Great Britain, and on the ansfer of the administration in 1910 of the Obervatories at Richmond and at Eskdalemuir from ne National Physical Laboratory to the Meteoroogical Committee, it accepted the responsibility also f nominating superintendents of the three observaories attached to the Meteorological Office at which eophysical work was undertaken, namely, Kew, skdalemuir, Valencia. At the termination of his rst year, Dr. Crichton Mitchell was reappointed for ne duration of the War or longer if it were necessary. he appointment so begun has continued for eight ears and a half with great advantage to the obervatories and considerable enlargement of their cope. The work now includes the climatological ork taken over from the Scottish Meteorological ociety in 1913 and the expansion of the meteoroogical station at Lerwick into a geophysical obervatory, when certain buildings became available here after the War, as well as the work on daily eather at Scottish stations for the Air Ministry. r. Mitchell brought to his task the enthusiasm for hysical science engendered in the University of dinburgh in the time of Tait, Crum Brown, and hrystal, the practical experience of managing an bservatory at Trivandrum, and the administrative xperience of the educational department of Travanore. That he should have been available for eveloping his special gifts of organisation in Scotland ast in the dark days of the War must be regarded s an example of good fortune for the geophysical iences, which otherwise labour under considerable isadvantages.

THE *Morning Post* has discussed recently the question of why "science does not pay." It is true that in many cases technically trained men fail to make much direct use of the knowledge they acquire at college in their subsequent life. But we know that the scientific training they have undergone has indirectly often been of the greatest value to them. We are not impressed by the fact that sometimes a municipality offers a beggarly salary for a technically trained assistant. Unless the prospects are good, there is little chance of a suitable man being obtained. Young men like posts where there is a chance, even if only remote, of ultimately getting a lucrative and influential position. For this reason they are content to receive a less salary than a mechanic of the same age would be allowed by his Trade Union to accept. Even a Covent Garden porter demands a guaranteed minimum of 4*l.* 5*s.* per week, whilst many technically trained men accept readily initial salaries less than this. A junior engineer in works, even although he has had works experience, often begins on a less salary than the minimum given in the Burnham scale for secondary school teachers. But capable men have good chances of promotion to better posts, and if they are enthusiastic for their profession, they do not grumble even when promotion seems remote. The remedy for unemployment is the development of national resources, and this calls, as Prof. J. A. Fleming says in a letter to our contemporary, for new ideas, initiative, and invention. Many manufacturers are fully alive to this fact, and we think that nowadays they all hold science in high esteem. In the engineering profession, there is a demand both for young men of the public school type, that is, men who get on well with manual workers, and for thoughtful men who love research and invention. A young honours graduate in science with works experience has little difficulty in getting a post in the electrical engineering profession. We think that the chances of promotion compare very favourably with other professions. It has been suggested that the Engineering Institutions look after the remuneration of their members and are simply glorified Trade Unions. This is not the case. They were founded for the advancement of science and its applications, and only enforce regulations on those engaged in any advisory or consultative capacity.

CERTAIN of the delegates attending the International Congress for the Protection of Nature held in Paris at the end of June 1923, felt that the object desired could be better effected by means of a smaller and more permanent organisation. An informal conference was therefore held at the Natural History Museum on November 2, at which it was decided that the Society for the Promotion of Nature Reserves should summon a meeting of organisations in Great Britain interested in the protection of animal and plant life, the promotion of Nature reserves, and kindred objects. The meeting was held at the Natural History Museum on January 14, under the chairmanship of Viscount Ullswater, and as the outcome the Central Correlating Committee for the Protection of Nature was set up, and it is believed

that similar committees will be formed in other countries. The constituent organisations of the British Committee and their representatives are as follows: The Trustees of the British Museum, Lord Rothschild (chairman); British Ornithologists' Union, Maj. A. G. L. Sladen; Entomological Society, Mr. W. G. Sheldon; International Committee for the Protection of Wild Birds, Mr. Hugh Gladstone; Linnean Society, Sir Sidney Harmer; National Trust for Places of Historic Interest and Natural Beauty, Mr. E. G. B. Meade-Waldo; Royal Society for the Protection of Birds, Mr. F. E. Lemon; Society for the Preservation of the Fauna of the Empire, Maj. Stevenson Hamilton; Society for the Promotion of Nature Reserves, Earl Buxton; Zoological Society of London, Dr. P. Chalmers Mitchell. Dr. G. F. Herbert Smith, Natural History Museum, S.W.7, is the Honorary Secretary-treasurer.

THE new Anglo-Dutch telephone cable which connects Domburg, Walcheren, on the Dutch coast, with Aldeburgh has been successfully laid. The length of the cable is 86 nautical miles. Pupin coils are not used, but each of the sixteen conductors is continuously "loaded" with iron wire. The British Post Office and the Dutch Telegraph Administration are to be congratulated on having such well-founded faith in mathematical theory. Through such a long length of cable, speech would be hopelessly distorted were it not for the loading. Another novelty is the use of paper instead of gutta-percha or ballata for the dielectric. This reduces the leakage and lowers the electrostatic capacity, both highly desirable results As strong tides and currents prevail in the Channel and North Sea, substantial armouring in addition to two lead sheaths are employed. To obviate the necessity of having to make numerous joints, the cable was constructed in ten-mile lengths, and the s.s. *Faraday* was fortunate in having calm weather during the process of laying the cable. The weight of the cable exceeds 2000 tons, and Messrs. Siemens Brothers and Co. had to build a special shop and erect new machines in order to make it. The tests show that the cross-talk between the core circuits and between a physical and its associated "phantom" circuit were less than the minimum specified. It is hoped that a good telephone service between Britain and continental countries will foster trade and promote better political relations.

THE electrical transmission of photographs has been an accomplished fact for some time past, and the principle involved is simple. A very small pencil of light passes through the surface of a cylinder and impinges upon a photo-electric cell at its axis. The negative to be transmitted is wrapped round the cylinder, and as the latter revolves with a fine screw-like movement, every part of the negative passes in turn between the light pencil and the photo-electric cell and regulates the current according to its density. The receiver at the other end of the wire consists of a cylinder that revolves synchronously with the sending cylinder, and is covered with a sensitive photographic film upon which impinges a very fine pencil of light after it has passed throug a "light-valve" which allows light to pass throug it of an intensity that is regulated by the trans mitted current. It is but a step from the sendin of a simple photograph to the transmission of th three colour-records of a colour photograph. Thi we learn from the Colour Supplement of the *Britis Journal of Photography* for September has recentl been successfully done at the instigation of Mr S. H. Horgan over a line about a thousand mile long, namely, from Chicago to New York. Mr Horgan made a three-colour lantern slide from th records as received, and says that the Wester Electric Company were "amazed at the beautifu and faithful colours shown in the slide."

IN connexion with the British Empire Exhibitior the British Dyestuffs Corporation, Ltd., has publishe an illustrated booklet which tells the story of th discovery in 1856 of the first artificial dyestuff b W. H. Perkin, who was then but eighteen years old and of the subsequent vicissitudes and successes o the dyestuffs industry in Great Britain. Withi twenty years of that chance discovery, German had taken the lead among the dye-producing nations and Great Britain was importing 80 per cent. of he requirements from continental sources. The declin and fall of British initial supremacy in this field ha been attributed to many causes, but the author o this pamphlet is convinced that neglect of researc was the most potent. The renascence of the industr during the War, the energy and resourcefulness o the firms that had survived foreign competition, th establishment of the Corporation about five year ago, and the reversal of the 4 : 1 ratio of imports t home manufactures, are events and achievements too recent to have been forgotten by the scientific world but their reiteration from time to time to those wh can with difficulty understand the fundamenta importance of a vigorous organic chemical industr is both useful and necessary. It is interesting t note that since its inception the Corporation ha expended 450,000*l.* on research; that it now employ 125 chemists, 83 per cent. of whom possess high university degrees, 30 colourists, about 30 engineers and approximately 3000 workpeople. The fiv factories owned by it occupy 600 acres of land, an consume annually 80,000 tons of coal, 30 millio units of electricity, and 2000 million gallons of water Facts like these speak for themselves.

DURING recent years the Government of Grea Britain has been increasingly active in institutin measures for dealing with the diseases and pests o cultivated plants and crops, and J. C. F. Fryer an G. H. Pethybridge (*Journ. Min. Agric.*, July 1924 have drawn up a useful historical summary an résumé of the present position of the phytopathologica service of England and Wales. In the early years after the passing of the Privy Council orders against the Colorado potato beetle in 1877, all research an advisory work was dependent upon the efforts o individual scientific workers. No official service wa organised until the passing of the Development an

Land Improvement Funds Act, 1909, which provided resources for a definite scheme of research investigation and advisory work in agricultural and horticultural plant pathology. This service has developed into two distinct, but co-ordinated, organisations, one consisting of a body of Government officials under the direct control of the Ministry of Agriculture, and the other of a number of scientific workers in the various universities, agricultural colleges, and research institutes, financed from Government funds, but free from the detailed instructions of the Ministry and subject only to a certain amount of supervision to secure efficiency. The résumé indicates the subdivision of the work among the various units of these two sections. Diagnosis of diseases and pests in the field is the function of a corps of advisors, and investigations into fundamental problems such as those relating to the physiological action of insecticides and the nature of immunity and resistance to disease are carried on by the research workers in various institutions. The official body deals with the collection and distribution of information, the practical work of administering existing legislation with regard to diseases and pests, and the control of plants coming into or exported from Great Britain. Although each part of the service is independent, an increasing degree of co-operation exists in dealing with problems of all types, thus enabling more rapid and efficient progress to be made.

A PERIOD of frequent rainfall, which has prevailed over the British Isles since the commencement of April, is dealt with in the *Meteorological Magazine* for September by Mr. C. E. P. Brooks, of the Meteorological Office. The rainfall is given for the period of five months, April to August. The percentage of the average rainfall, 1881–1915, is given for different parts of the British Isles. The excess is least in Scotland, where for the five months it amounts to 126 per cent. of the average. In Ireland it is 131 per cent., in England and Wales 146 per cent., and for the British Isles generally, 138 per cent. of the average. For the south-east of England the fall is 161 per cent. of the average, and in each month with the exception of June the percentage of the average rainfall is greater in the south-east of England than in any of the larger divisions of the British Isles. The five months in question are said to have proved a decidedly rainy period, although not excessively so; the rains were chiefly cyclonic. Details are given showing the influence of travelling Atlantic depressions on the weather of the British Isles, an inquiry which some day may yield data to assist in long-period forecasting.

THE Chinese floods are somewhat explained in the *Meteorological Magazine* for September. The floods are referred to as unparalleled in the present century. It is stated that in the province of Chih-li 25,000 square miles are under water, and it is estimated that nearly five million people are homeless. The water is 3 feet higher than in the flood of 1917, when the material damage was estimated at 25,000,000*l*. Between Tientsin and the Shansi Mountains is the meeting ground of five rivers, and a great quantity of silt is brought down from the mountains; this raises the level of the river bed. The waters are greatly restrained by embankments, and if a gap is broken a river may flood a wide area of the country. The average rainfall is about 20 inches a year, which falls almost entirely in the three summer months July-September. This summer the rainfall has been abnormally heavy; at Pekin, the fall in July was 26 inches, and at Tientsin 32 inches fell in three weeks. These heavy rains have broken numerous gaps in the banks, causing disastrous floods over all the low-lying country. The meteorological situation favouring floods in North China is dealt with, and reference is made to an article in the *Times* of September 2, which alludes to definite plans having been prepared after the disaster of 1917 to avert the danger of similar floods.

IT is announced in the *Observatory* that Prof. H. Kopff, of the Heidelberg Observatory, has been appointed professor of theoretical astronomy in the University of Berlin and Director of the Astronomischen Recheninstituts.

A DIRECTOR of the Norfolk Agricultural Station is required. Candidates for the position must possess a university degree or diploma, a modern scientific training in agriculture, first-hand experience of arable agriculture, organising ability and facility in lecturing. The latest date for the receipt of applications, which should be sent to the Secretary, Norfolk Agricultural Station, 11 Bridewell Alley, Norwich, is October 11.

AN assistant is required in the British Museum Laboratory for research in connexion with the cleaning and restoration of museum exhibits. Candidates must be honours graduates in chemistry, with research experience and a wide general knowledge of chemistry, with, if possible, training in mycology and an interest in archæology. Applications for the post should be sent, upon a prescribed form, not later than October 11 to the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1.

APPLICATIONS are invited for positions under the Ceylon Government of a mycologist and a systematic botanist. The first named, if a senior officer with tropical experience, will be placed in charge of the mycological division; the second will be required to take charge of the systematic work in the Botanic Gardens of the Colony, to make researches into the flora of Ceylon, and to study especially the ecology of Ceylon plants. The posts will become vacant about July next. Applications must be made upon a special form obtainable from the Private Secretary (Appointments), Colonial Office, S.W.1.

THE Secretary of State for the Colonies has appointed a committee to advise him on matters relating to the recruitment and training of officers for the agricultural departments of the non-self-governing dependencies. The committee will be constituted as follows: Lord Milner (chairman), Lord Lovat (vice-chairman), Sir Arthur Shipley, Sir Daniel Hall, Prof. J. B. Farmer, Dr. A. W. Hill, Mr. F. B. Smith, Major R. D. Furse, with Mr. P. A. Clutterbuck, of the Colonial Office, as secretary.

A GENERAL discussion on the physical chemistry of igneous rock formation is to be held in the rooms of the Geological Society, Burlington House, London, on Wednesday, October 22, beginning at 3 P.M. The meeting is being organised under the joint auspices of the Faraday Society, the Geological Society, and the Mineralogical Society. A general introduction will be contributed by Dr. J. S. Flett, and papers are expected from Prof. C. H. Desch, Dr. J. W. Evans, Prof. J. W. Gregory, Mr. A. F. Hallimond, Prof. Paul Niggli, Dr. A. Richardson, Dr. A. Scott, Mr. G. W. Tyrrell, and Dr. W. E. S. Turner. Further particulars relating to the meeting may be obtained from Mr. F. S. Spiers, 90 Great Russell Street, London, W.C.1.

THE Educational Number of the *British Medical Journal* (September 6) contains an article by Dr. Andrew Balfour on the teaching of public health, i which he reviews approvingly the provisions of th new regulations for the Diploma of Public Healt introduced by the General Medical Council o January 1 this year. The medical practitioner ca now obtain the Diploma only after he has bee qualified for two years and the period of stud extends over one year. Dr. Balfour also details th provisional scheme of lectures and practical wor of the new London School of Hygiene and Tropic Medicine, of which he is the first Director. Th London School of Tropical Medicine has just bee incorporated in this new School, the buildings f which will be ready in about two years' time and a being built and equipped by the generous gift of tw million dollars by the Rockefeller Foundation. A account of the circumstances of the foundation of th School appeared in NATURE of July 28, 1923, p. 149

Our Astronomical Column.

NEW COMET, 1924 *c*.—A comet of the eighth magnitude, with a tail, was discovered by Mr. Finsler at Bonn on September 15. The following positions have been received, the first two being approximate only :

G.M.T.	R.A.	N. Decl.	Place.
Sept. 15·27	13h 13m 0s	19° 0′	Bonn.
17·27	13 35 0	16 0	Bonn.
19·276	13 52 8	12 7	Babelsberg.

From these the following orbit has been deduced, but as the observations are not exact, it may be considerably in error :

$T = 1924$, Sept. 4·15 G.M.T.
$\omega = 67° 9′$.
$\Omega = 87° 46′$.
$i = 114° 48′$.
$\log q = 9·5940$.

The following positions are calculated from these elements, for Greenwich midnight :

	R.A.	S. Decl.	log *r*.	log Δ.
Sept. 28.	14h 50m 44s	1° 13′	9·8660	0·0801
Oct. 2.	15 7 36	5 33	9·9095	0·1190

SOLAR PHYSICS AT CAMBRIDGE.—The eleventh annual report of the Director of the Solar Physics Observatory at Cambridge, covering the period April 1, 1923–March 31, 1924, has just been published. The bulk of the work accomplished falls under the three headings—stellar work, solar work, meteorological physics. Under the first heading come the very valuable theoretical investigations of Messrs. E. A. Milne and R. H. Fowler, by means of which they have given more precision to the method devised by Prof. M. N. Saha of calculating stellar temperatures and pressures from the degree of ionisation of atoms in the atmospheres of the stars. Furthermore, stellar data, in the light of modern theory, have now been made available for the solution of certain physical problems. On the experimental side, Mr. Baxandall has identified certain absorption bands in the spectra of S-type stars with bands of zirconium oxide—an identification which has since been confirmed by Mr. Merrill at Mount Wilson. The chief solar work of the year, other than routine observations, has been the systematic examination of flocculi by Mr. Butler, and the study, by the Director and Mrs. Beech, of areas and proper motions of sun-spots in the light of the Mount Wilson discovery that the true sun-spot cycle covers a period of 22 instead of 11 years. Mr. Moss has examined the daily records obtained at Kodaikanal of the distribution of prominences at the sun's limb for the years 1904–1922, and has obtained interesting indications of loci on the sun's surface specially favoured by prominence The correlation of the phenomena of sun-spot flocculi, and prominences has thus been the ou standing solar work of the observatory. On th meteorological side, Mr. C. T. R. Wilson has co tinued his investigations of ionising radiations b the "cloud" method, while Dr. E. V. Appleton h been investigating the changes of potential gradie due to very distant lightning discharges, which a regarded as the sources of the disturbances know as "atmospherics" in wireless telegraphy.

RADIATION AND MASSES OF STARS.—Prof. H. Vo describes an investigation into the relation betwee the masses of a number of double stars in th *Zeitschrift für Physik* of August 8; he deals wit 85 double stars from the Lick Observatory Bulleti No. 343, and others which have been considered b Eddington. The masses were calculated from th absolute brightness and the temperature as dete mined from the spectrum, using Eddington's formul and thus the mean ratio between the masses of th brighter and fainter components was determined f different spectral classes (bright component).

The following table shows the result, Mb/Mf bein the ratio of the mass of the bright to that of th faint component, S the spectral class of the brigh component, and n the number of stars considered :

Giants.			Dwarfs.		
S	Mb/Mf	n	S	Mb/Mf	n
M	18·4	2	A	1·6	9
K	2·7	6	F	1·3	23
G	1·9	9	G	1·25	18
F	3·0	5	K	1·23	11
B	4·6	8	M	1·19	2

If one double star is left out from the five F giant Mb/Mf for this class becomes 1·7, and then, with th exception of the B giants, the ratio diminishe towards unity as the state of development of th stars progresses, as would be the case if the mas diminished with the radiation. Assuming that whe a brighter component is in the A (dwarf) class, it mass is 2·5 and the mass ratio Mb/Mf is 1·6, an that both components diminish in proportion t the radiation output, then if Mb has the values give below, in passing through the later spectral classes the values of Mb/Mf are as given in the third lin and may be compared with the values of Mb/M above :

	A	F	G	K	M
Mb . .	2·5	1·5	1·0	0·7	0·4
Mb/Mf .	1·6	1·2	1·10	1·06	1·04

Research Items.

ENGLISH GYPSY BURIAL CUSTOMS.—Mr. T. W. Thompson continues his interesting study of gypsy burial customs in the Journal of the Gypsy Lore Society, Third Series, Vol. III., Pt. 2. Although burials in unconsecrated ground are recorded, the evidence does not on the whole support the view held by some that this was, at one time, the normal practice. In the Heron family, however, only one burial appears in parish registers between 1650 and 1830. The most characteristic funeral rite of the English gypsies was the sacrifice of all the belongings of the deceased which were not buried with the body. The tent and surplus clothes were burnt, possessions which could not be burnt were buried, and the horses and donkeys were sold to gorgios or, in earlier days, were killed. In some cases the living wagon was burnt, even when the deceased was not the owner but only a member of the family, or a child. The reason would appear to be fear that the dead would be restless and jealous at others using their property rather than a dread of pollution, though this may not be entirely absent. In like manner the objects buried with the dead and the offerings made at the grave, though possibly in some degree intended for his service, were primarily to protect the living by making him happy and contented. This dread of the return of the dead is also shown by the avoidance of the names of near relatives no longer living. If another relative or friend bears the same name, a fresh name or nickname is used. Although to swear by a dead relative is the most solemn oath a gypsy can use, a descriptive phrase is substituted for the name. Gypsies also avoid camping places used by the deceased, and, more commonly, abstain by vow or otherwise from his favourite drink, food, or amusement.

IRON WORKING IN THE CAMEROONS.—In *Man* for September, Mr. L. W. G. Malcolm gives an account of iron-working in the Bagam area of the Cameroons. Trades are here under the direct control of the head chief and are specialised, a tradesman being a privileged person and exempt from all work other than his own. Each trade is a guild to which a limited number of apprentices is allocated. No stranger is allowed to enter an iron-smelting hut without a ceremony which includes aspersion of the stranger and the sacrifice and eating by the workers of a fowl purchased by him. The furnace, which is housed in a low hut, differs from the usual West African type in being built in a pit with a sloping approach. It appears to be a development of the Kordofan type, but is much larger. It is square in horizontal section with a back of the natural ground, the sides and front being of clay mixed with chopped grass. The charging hole is on the top between the two sets of bellows, which are arranged on the solid earth at the back, and the gas escape tube. Each bellows has a tuyère, of which the lower end rests on the fire-bed inside the furnace. When the furnace has been lit and charged, which is done gradually, it is kept in full blast by relays of blowers for twenty-four hours. The amount of metal produced at each reduction is about sixty pounds.

THE ANCESTORS OF MAN.—In a popular article contributed by Prof. Henry Fairfield Osborn to the June number of *Asia*, he emphasises his belief that the Tertiary ancestors of man will be discovered in the high plateau region of central Asia. He therefore looks forward with eager anticipation to the results of the new expedition which has been sent by the American Museum of Natural History to collect fossils in Mongolia. Prof. Osborn asserts that "the arboreal theory of man's origin has been given up," and adds that "his ancestors, if tree-living, left their trees in the middle period of the Age of Mammals." He considers that man was driven to live in caves in western Europe by the advance of the ice sheet and the consequent cold conditions during part of the glacial period. It was an episode "of vast importance in the mental and spiritual development of the race, just as the previous period of life in the open was one conducive to its physical and moral development." He thinks that man lived in the open for a comparatively long period, the oldest known race being represented by the flint implements and fireplaces discovered in the Pliocene Crag of Foxhall, Suffolk. Prof. Osborn's article is written to counteract the influence of Mr. W. J. Bryan, who has lately published many attacks on the doctrine of organic evolution, and seems to have a large following in the United States of America.

THE STIFLING OF SILKWORM COCOONS.—In the Bulletin de la Société d'Encouragement pour l'Industrie Nationale for June, M. G. Bertrand describes how extremely sensitive the chrysalides of the silkworm are to the vapour of chloropicrin. The shell in which the chrysalides are naturally enclosed does not protect them appreciably from attack by the vapour, which ensures a complete and rapid stifling of the cocoon. One gram of this agent per 1000 gm. of cocoons acting for one hour at 20° C. will effect the desired result, even if double cocoons are present. On exposure to air, the cocoons lose practically all odour of chloropicrin and dry readily. The stifling produced in this way, which is equal and sometimes even superior to that secured in the usual "dry and humid heat" industrial processes, does not affect the silky envelope, the colour and other original qualities of the cocoons being retained. Neither do the spinning qualities decline. The tenacity and elasticity of the fibres obtained by the new and old processes are found to be the same. The author emphasises the fact that the new method is, both from the academical and industrial points of view, economical, and requires less supervision, since the margin of safety, without fear of damage to the silk, is very considerable. It is claimed that the chloropicrin process is convenient and certain, has no objectionable action on the silk, and requires no complicated or costly installation.

PROTOZOAN PARASITES OF OLIGOCHÆTE WORMS.—The freshwater Oligochætes have long been known to harbour a variety of interesting protozoan parasites. The study of these has lately been taken up by Dr. Doris L. Mackinnon and Miss D. Ines Adam, who contribute two important papers on the subject to the *Quarterly Journal of Microscopical Science* (vol. 68, Part II.). The first of these deals with the life-history of the remarkable genus Triactinomyxon, a genus so complex in its structure and development that it has been doubted whether it is really a Protozoon at all. The peculiar triradiate "spores," with their thread-capsules, so similar to those of the Cœlenterata, are described and figured, and an admirably clear and straightforward account of the life-history is given, with copious illustrations. Most of the known species of the genus occur in the common Thames worm, Tubifex, and the authors' account is based chiefly upon a new species, to which they have given the name *Triactinomyxon legeri*. The second memoir deals with four astomatous Ciliates parasitic in the genera Tubifex, Nais, and Lumbriculus. The authors remark that if a really satisfactory classification of the astomatous Ciliates is ever to be made, it

is necessary that many more of the earliest recorded forms should be re-investigated and re-identified, and their work forms a noteworthy contribution to the subject.

ALKALOIDS FROM DATURA.—The Bulletin of the Imperial Institute (vol. 22, p. 134) contains the results of analyses of *Datura metel*. It appears that if the flowers of this plant are removed during cultivation so that no fruits appear, the yield of alkaloids is increased from 0·24 to 0·36 per cent., the former figure being obtained for normal fruiting plants. Further, the alkaloid present consists almost entirely of scopolamine in deflowered specimens, while in normal plants only about one-fifth of the alkaloid is scopolamine, the remainder being hyoscyamine.

NORTH AMERICAN SPECIES OF ARISTIDA.—Mr. A. S. Hitchcock has described (Contrib. U.S. Nat. Herbarium, 22, 1924, p. 517) the North American needle-grasses of the genus Aristida. These grasses, although widely distributed throughout the world in steppes and prairies, and of considerable economic importance, are only to be distinguished with difficulty and have not always been adequately described. This paper represents a large amount of work and it removes many difficulties. Seven new species are described, together with a number of new combinations.

VARIABILITY IN FUNGI.—Mr. H. R. Briton-Jones records the results of cultural work on *Rhizoctonia Solani* Kühn in the Transactions of the British Mycological Society, vol. 9, p. 200. This fungus is responsible for the "sore-shin" disease of cotton seedlings. A number of forms from Egyptian cotton, from Missouri, U.S.A., India, and also from English peas and potatoes, were examined and induced to produce the fertile stage, *Corticium vagum*, under culture. The various strains remained more or less distinct throughout the experiments, even when allowed to infect a common host plant. They showed; moreover, different physiological properties. Thus the foreign strains, unlike those from Great Britain, were unable to grow at temperatures of 5-8° C. The fungus grows best at the surface of moist, not dry, jellies, just as in Nature it attacks its host plants at the ground level where comparable conditions obtain.

AMERICAN CAMBRIAN GEOLOGY AND PALÆONTOLOGY.—The veteran American palæontologist, Charles Doolittle Walcott, although past the allotted span of life, is, we are glad to see, still ably carrying on the work begun in 1908 of describing the primary fossils of America, and has just brought out Part 9 of vol. iv. of his "Cambrian Geology and Paleontology" (Smithsonian Miscell. Publicat., lxvii.). The present part deals with the Cambrian and Ozarkian Brachiopoda, as well as two new species of Cephalopoda and a new genus, Ozomia, of the family Technophoridæ, formerly considered to be Pelecypods, but now referred to Sars's order Notostraca. The Brachiopoda come principally from Alberta and British Columbia, with a few from various localities in the United States, and a small collection from Novaya Zemlya. These are fully set forth and systematically described, and include fifty new species and a new variety. There are twenty most excellent plates of figures based for the most part on photographs.

MIOCENE FORAMINIFERA.—The mere mention of Foraminifera at once recalls to mind the great triumvirate of Parker, Jones, and Brady, who laid the foundations of our present knowledge of the order, while Jones's pupil, C. Davies Sherborn, compiled a "Bibliography" and an "Index" unsurpassed at the time. Later, the work was carri on by F. Chapman, now in Australia, but the histori graphers in this century of these fascinating but mo puzzling little animals have been Heron-Allen a Earland, whose joint works are familiar and i dispensable to all students. These authors have ju published (Journ. R. Micro. Soc., 1924) an elabora paper on the "Miocene Foraminifera of the 'Filt Quarry,' Hoorabool River, Victoria, Australia which is to be regarded as a supplement to Chapman "Study of the Batesford Limestone," that writ being unable to carry it on further. The materi dealt with consisted of about half a pint of whi organic deposit from the Filter Quarry, which i Foraminiferal contents show must have been la down in a tropical sea at a depth of from 50 to 1 fathoms under conditions very similar to tho existing at the present day round the northe coasts of Australia. A sample from the overlyi marl, taken by Dr. T. S. Hall, indicated that, althou laid down in about the same depth, it must ha been deposited within the continental mud lin Altogether the authors fully describe two hundr and seventy species and varieties, nineteen of whi are held to be new. The new and a few previous named species are amply figured on eight plat containing 118 figures.

KNOLL-REEFS AND THE CRAVEN FAULTS.—In the paper on "The Lower Carboniferous Succession in t Settle District" (Quart. Jour. Geol. Soc., vol. lxx pp. 184-273, 1924), Prof. E. J. Garwood and Mi Edith Goodyear discuss a number of outstandi problems that have hitherto awaited a satisfacto solution. It is shown that the whole of the succe sion north of the North Craven Fault belongs to t North-Western Province, and that in general the Midd Craven Fault may be taken as the southern limit this province. To the south the beds show almo everywhere an abrupt change to the southern type development. Structurally, however, the change complicated by the occurrence between the faults knoll-reefs which belong to the Southern facies, ar by the presence of Yoredale rocks south of the Midd Fault. The knoll-reef limestone of the High Hills of D_3 age and therefore cannot pass laterally into t D_1 limestone against which it abuts on the nort Although there is no other evidence of thrusting, it suggested that the beds have been brought togeth by movement from the fractured southern are against the rigid and undisturbed northern bloc Thrusting seems also to explain the abrupt chan from Southern to North-Western facies. With rega to the origin of the knoll-reef structure, Marr's co tention that limestones of any kind can be folded in knoll-like domes is fully substantiated. It is al shown that the typical knoll-reefs of the souther succession owe their form partly, as suggested b Tiddeman, to the original deposition of rich accum lations of organic remains, and partly to the accentu tion of the quaquaversal structure by subsequer movements.

DISTRIBUTION OF PHILIPPINE EARTHQUAKES.—I the recently issued Bulletin for May 1922 of th Manila Weather Bureau, the Rev. M. Saderra Mas considers the distribution of earthquakes in th neighbourhood of Butuan (northern Mindanao basing his conclusions on the records of six year The average monthly number of earthquakes registere by a Wiechert seismograph at Butuan (1916–1921) i 90. The earthquakes originate in four princip seismic zones. In the first (30-50 km. from Butuan the earthquakes come chiefly from a shallow centr in Butuan Bay. The second and most importan

zone (80-160 km.) includes the whole central and deepest part of the Philippine Deep; the third (270-300 km.) contains the central and southern extension of the Agusan valley (a zone responsible for the great earthquakes of 1893, 1894, and 1911); and the fourth (400-500 km.) the unstable north-east portion of the Celebes Sea. The zone of minimum frequency (0-80 km.) embraces most of the eastern and central Cordilleras, in the latter of which no sensible earthquake, so far as known, has ever originated.

SURVEYS IN SPITSBERGEN.—An article by Mr. J. A. Frazer in the *Geographical Journal* for September gives an account of some explorations carried out by him, in conjunction with Messrs. N. E. Odell and G. Milling and the late Mr. A. C. Irvine, in Central Spitsbergen in August 1923. Their object was to amplify and extend the preliminary survey made in that region in 1921. Landing at Duym Point in Hinlopen Strait, they crossed the island via the Heydenius range and Mount Chernichev to the head of Klaas Billen Bay. The area traversed, which lies to the south of the New Friesland ice-sheet, proves to be a region of complex topography from which the glaciers drain mainly to the east. A provisional map of this small area is published. It is based on photogrammetric work, but it must await the precise positions of the northern beacons of the Russo-Swedish Arc of Meridian surveys before a final version can be prepared. Only the approximate positions of these beacons have so far been published.

DISINTEGRATION OF RADIUM-C.—The September issue of the *Philosophical Magazine* contains an account of the experiments which have been made by Sir Ernest Rutherford and Dr. J. Chadwick to determine the origin and nature of the long range particles which appear from a source of radium-C. They find that the particles of range 9·3 cm. appear in equal amounts in vacuum, helium, oxygen, carbon monoxide and zenon, in whatever way the source is prepared and whether it is covered by a sheet of mica or silica or left uncovered. The paths of the particles as determined by a shadow method and as deflected by a magnetic field lead to the conclusion that the particles are α-particles arising from the disintegration of the radium-C, and are not due to the disintegration of the gas through which the α-particles pass. The same conclusion appears to be probable with regard to the particles of range 1·2 cm., and the two groups probably represent new types of disintegration of radium-C.

THE MEASUREMENT OF FEEBLE RADIOACTIVITY.—A method of measuring weak radioactivity by means of a photographic record of the drift of an electrometer, charged by the ionisation current produced by β- and γ-radiation, is described by Dr. G. Hoffmann in the *Zeitschrift für Physik* of July 12. The ionisation chamber consists of a very open wire cage, the potential of which is kept at 240 volts, and containing an electrode connected to the electrometer. The cage is cleaned with acid and is contained in a brass box, from which the air can be pumped and replaced by carbon dioxide from a steel cylinder. The carbon dioxide, when fresh, contains no emanation. The whole apparatus is surrounded by thick lead cylinders, and the substance to be examined is powdered on a sheet of tinfoil covered with a thin layer of shellac, and placed in a holder round the inner surface of the brass box. All α-rays are absorbed by the carbon dioxide before they reach the cage, and so do not cause rushes of ionisation and irregularities in the photographic record. Among other experiments made with the apparatus, the radioactivity of sodium and cæsium has been studied; taking that of potassium as unity, sodium gives less than 0·002, and cæsium from polluxite, which contains no rubidium, shows no trace of radioactivity.

THE CRYSTALLINE STRUCTURE OF GRAPHITE.—In the *Zeitschrift für Physik* of August 4, Messrs. O. Hassel and H. Mark describe an investigation designed to clear up the discrepancy between the results of Debye and Scherrer and those of Hull; single crystals, natural and artificial, and polycrystalline material were employed, and great care was taken to avoid distorting the soft material, which, when in the form of powder, was not pressed into rods, but fastened with collodium to a thin wool thread, stretched in the axis of the camera. Different characteristic X-radiations were employed, and the rotation diagram method, the Laue method, Bragg's reflection method, and the Debye-Scherrer method were all made use of, the intensity relations of the reflections being determined. Consideration of the whole of the diagrams in detail showed that, if all the carbon atoms have the same valency, there is no space group which gives the observed interferences. It is necessary to assume a *c*-edge-centred lattice, with particles having the reflecting power R_1, shifted a certain amount with respect to a lattice with reflecting power R_2 and with the particles in the positions for closest packing; the smallest possible orthohexagonal cell measures $a = 2{\cdot}47$ Å, $b = 4{\cdot}25$ Å, $c = 6{\cdot}70$ Å, and contains eight atoms; a figure in the original paper shows the relations between the particles. The measurements of Ewald, Debye, Scherrer, and Hull agree with the structure determined.

GLASS TECHNOLOGY.—The Experimental Researches and Reports published by the Department of Glass Technology of Sheffield contains in volume 6, 1923, among other papers, one on natural sillimanite as a refractory material, by S. English, and one on heat-resisting glasses by Prof. Turner. The first paper gives an account of some trials of natural sillimanite, which melts at 1816°, in place of clay as a refractory. Mixtures with clay were used. The mixture with 9 per cent. of clay showed a very small shrinkage on drying, and on burning at 1400° the further contraction was negligible. The porosity was rather less than standard pot clay, and the action of molten glass was much less than that on clay. Prof. Turner's paper gives an interesting account of the developments in the manufacture of heat-resisting glasses, beginning with the systematic work of Schott at Jena in 1892, and including "Pyrex" glass containing 80·62 per cent. of silica, 11·9 of boric anhydride, 2 per cent. of alumina, 3·83 per cent. of soda, and small quantities of other constituents. In America, tea and coffee pots, tea-cups, and cooking ware are made from refractory glass.

SODIUM TUNGSTATES.—We have received a reprint of a paper on sodium tungstates by Dr. E. F. Smith, published as a contribution from the John Harrison Laboratory of Chemistry, University of Pennsylvania. The sodium tungstates described in the literature were re-examined, and the conditions for preparing 5:12 sodium tungstate determined. With normal sodium tungstate (1:1) and meta-sodium tungstate (1:4) as opposites in basic and acid character, the intermediates 3:7, 5:12, and 4:10 were found as products of their union. The 1:2 and 1:3 salts do not exist, probably because of their very ready hydrolysis. The suggestion that paratungstates exist in two modifications, namely, 3:7 and 5:12, was not confirmed. Carbon tetrachloride as a new reagent was extensively employed.

The Japanese Earthquake of 1923.

SOON after the earthquake of September 1, 1923, the Imperial Earthquake Investigation Committee appointed a number of sub-committees to investigate the earthquake from different points of view, dealing with observations on seismology, geology, hydrography, and geodesy, and, on the practical side, with problems of architecture and civil engineering. The complete reports of the various sub-committees will, it is expected, be published before many months are over. In the meantime, Prof. A. Imamura, who has succeeded Prof. Omori as the head of the Investigation Committee, has written a valuable report which appears in No. 6 of the "Seismological Notes" of the Committee.

As Prof. Imamura points out, the earthquake was by no means the most severe that has visited the Japanese Empire—it was inferior, for example, to the Tokyo earthquake of 1855—though, in the destruction of life and property, it is probably without a rival. After five minutes, the motion had so far subsided that Prof. Imamura was able to visit the observatory of the Seismological Institute. Here he found that nearly all the instruments were wrecked. Only one component of one seismograph kept working all through the earthquake, but, within five minutes, four seismographs (recording actual size or up to twice that size) were readjusted or repaired, other more sensitive instruments being added after a day or two. These repairs were impeded by the outbreak of fire in the University, and it was not until 10 P.M.—the earthquake occurred just before noon—that the Institute and its observatory could be regarded as safe. The office of the Investigation Committee was burnt with its important papers.

From the direction and duration of the preliminary tremors, it is estimated that the epicentre was 92 km. from Tokyo in the direction S. 26° W., that is, under Sagami Bay, in lat. 34° 58·6′ N., long. 139° 21·8′ E. The angle of emergence at Tokyo was 10°, giving a depth of about 15 km. for the focus. The curve representing the relation between the focal distance and the time of transit of the first tremors is practically a straight line, from which it is found that the time at the origin was 11 h. 58 m. 32 s., and the velocity of the first tremors 7·5 km. per sec. for the neighbourhood of the epicentre. The total duration of the record of the great shock was 2 h. 20 m.

From the initial direction of the movement at different places within a radius of 170 km., Prof. Imamura concludes that "the seismic action might have been applied in such a manner that the compression along a deep stratum was directed towards the north and west."

The greater part of the coast of Sagami and Tokyo Bays was elevated, the maximum amount of uplift being a little more than 2 metres. Such changes are slight compared with the displacements in the bed of Sagami Bay. The total area of depression is estimated at 700 sq. km. and that of elevation at 240 sq. km., the total volume depressed at 50 c. km., and the volume elevated at 20 c. km. This implies that the average depression was 39 fathoms and the average elevation 45 fathoms.

The tsunami, or seismic sea-waves, were greatest along the shores of Sagami Bay, where they reached a height of 8 metres at Ito and Aziro, 9 metres at Ainohama, and 12 metres at Atami. From the directions in which the sea-waves advanced, it follows that the most prominent waves came from neighbouring areas of elevation. The enormous depressions gave rise to only minor waves.

The cause of the earthquake is still unknown. Possibly there may have been a great fault-movement in the heart of Sagami Bay, but so far no trace of has been discovered. On land, two minor faults ha been observed, one near Nagasawa in the Miu peninsula, the other near Nago in the Bo-so peninsul Both are about 2 km. in length, and have a maximu vertical displacement of one metre.

Four slight shocks, with epicentres in or ne Sagami Bay, were registered at Tokyo during th preceding month, the last one eight days befo the earthquake. Otherwise, the great shock ca suddenly and without warning. The study of th after-shocks is complicated by the great size of th focal area, and by the occurrence of another destru tive earthquake, belonging to the same zone, and nearly equal strength, at 2 h. 47 m. on September the after-shocks of which mingled with those of th first earthquake. The after-shocks originated three areas, the first including the Bay and Provin of Sagami, the second the Bo-so peninsula and se bed to the east, and the third the drainage-area the River Tone to the north of Tokyo. Of the 12 after-shocks recorded at Tokyo during Septembe 46 (including the majority of the strong after-shock occurred in the first zone, 71 in the second, and 25 the third, while the epicentres of more than a thousan (nearly all slight and none strong) are unknown.

The latest statistics show that the total numb of lives lost was 99,331 (59,065 in Tokyo and 23,44 in Yokohama), 103,733 were wounded, and 43,47 missing. The number of houses completely collapse was 128,266, while 126,233 half collapsed, 447,128 we burnt, and 868 washed away. A second table giv the number of houses collapsed in the places mo severely damaged, and the percentage of such wit regard to the number of pre-existing houses. Yokohama the percentage was as low as 12·4, b in Kamakura it rose to 84·4, and in six plac it exceeded 90. In one of these (Simosoga) was 97·8.

A recent issue of the Bulletin of the Seismologic Society of America (vol. 13, 1923, pp. 124-14 contains an interesting article on the Japane earthquake by Dr. T. A. Jaggar, the well-know vulcanologist and founder of the Volcano Observato on Hawaii. Dr. Jaggar spent October in th meizoseismal area, and he has added many details t our knowledge of the earthquake. He estimates th value of property destroyed at between four and fi thousand million dollars, and states that some wel informed Japanese put the loss of life at about fo hundred thousand. The volcano of Oshima showe no unusual phenomena at the time of the earthquak Dr. Jaggar describes the changes of level of the flo of Sagami Bay and along the coast-line. These a summarised above and in NATURE, vol. 113, pp. 47 474. He considers that the belt of maximum d pression was the epicentral tract. "As the shorelin belts all about were lifted or lowered only one t eight feet, the depression mechanism was of a differe order from the margin mechanism. It appears t have been a collapse of blocks into a pit or rift in th bottom of the bay aligned with the island volcan chain, which extends hundreds of miles south-sout east." The after-shocks were of two kinds, th slow prolonged type (resembling the first shock) an the abrupt short type preceded by a booming nois Dr. Jaggar quotes at length the accounts of severa careful observers in Tokyo, Yokohama, etc. Wit regard to the place of the earthquake among othe great shocks, he concludes that it was not mor intense than the Mino-Owari (Japan) earthquake c 1891, and probably much weaker than the Yakuta Bay (Alaska) earthquakes of 1899. C. D.

Standardisation of Scientific Glassware.

THE Joint Committee for the Standardisation of Scientific Glassware, which was promoted by the Institute of Chemistry (30 Russell Square, W.C.1), and includes thirty-seven members representing mainly users and manufacturers, has published its first report, entitled "Units of Volume," in which is recorded the unanimous recommendation to discard the cubic centimetre as the standard unit for scientific glassware and to institute therefor the litre and the millilitre. Since, however, some chemists still prefer to use the Mohr unit, the Committee has added two further recommendations to obviate confusion between the two systems, although it hopes that in time the litre and the millilitre will be adopted exclusively. Vessels graduated on the Mohr system, it is recommended, should be marked "G.W.A." (grammes of water in air), and the numerical relation between the units will be 1000 G.W.A. = 1002 ml. The National Physical Laboratory will test vessels of both kinds, and those graduated on the Mohr system will be marked differently from the others.

Whereas the volume of a body of simple geometrical form is readily calculated from its linear dimensions, the volume of a hollow vessel designed to hold a fluid is determined more easily and more accurately by finding the weight of water required to fill it. But the use of two distinct types of units has many disadvantages, especially if there is no simple numerical relation between them. To establish such a relation, the originators of the metric system defined the kilogram as the mass of water which occupies one cubic decimetre at its temperature of maximum density; so that the unit of volume, the litre, could be defined either as a cubic decimetre or as the space occupied by a kilogram of water at the specified temperature. A cubic decimetre of water was, however, not a practical standard weight, and the kilogram was therefore re-defined as the mass of a particular standard weight (*kilogramme des Archives*). In accordance with this change, the litre was re-defined as the volume occupied by one kilogram of pure water at its temperature of maximum density and under normal atmospheric pressure. Thus the litre became independent of the metric unit of length, and the cubic centimetre lost its relation to the volume of a mass of water. The precise relation between the litre and the cubic centimetre was found experimentally to be 1 litre = 1000·027 c.c. ±0·001), a difference so small as to be negligible for ordinary volumetric glassware.

The introduction of the Mohr system caused confusion, inasmuch as by it the unit volume was defined in terms of the apparent weight in air of a mass of water at room temperature. By this system a "litre" flask contains 1000 gm. of water (weighed in air against brass weights) at 17·5° C., which is the equivalent of 1002 c.c. as defined above; but the followers of Mohr designated the volume occupied by the 1000 gm. of water one litre, and the thousandth part of it one cubic centimetre. The exact relation between the Mohr unit and the millilitre is given by the fact that the amount of water which weighs 1000 gm. in air of density 0·0012 gm./ml., when weighed against brass weights of density 8·4 gm./ml., occupies a volume of 1002·021 ml. at 60° F. The difference between this figure and 1002, namely, 2 parts in 100,000, is negligible in practice, and hence the Committee recommends the adoption of the round number, thus facilitating inter-conversion of "G.W.A." and millilitres.

The Committee has also considered the accuracy of volumetric glassware, and recommends the adoption of only two grades, namely, Class A, or Standard Apparatus, which must pass the N.P.L. or other approved test, and the Class B, or Commercial Grade Apparatus, of cheaper quality and for general use, which must, however, be guaranteed by the manufacturer to comply with certain minimum requirements. The Class A Tests and the Class B Tests of the National Physical Laboratory (as revised in a recent pamphlet to be obtained from The Director, N.P.L., Teddington, Middlesex) are approved, and confidence is expressed that manufacturers will be able to supply guaranteed Class B apparatus at reasonable prices. Finally, the Committee urges strongly that volumetric glassware should never be ordered without specifying the limits of accuracy required.

Cod and Cod Fishery.

THE three papers included in No. 7, vol. vi., series ii., Fishery Investigations, Ministry of Agriculture and Fisheries (H.M.S.O., price 3*s*.), record an investigation undertaken as part of the general programme of research on the cod which was initiated by the International Council for the Exploration of the Sea in 1921.

The first, under the initials of Mr. W. C. Smith, deals with the Irish Sea cod fishery. This fishery is of importance only during the winter months, and it is carried on chiefly by Manx long-line fishermen and a few Fleetwood steam-liners. With the approach of winter and the decreasing temperature of the water, large mature cod move into the Irish Sea from the north to spawn. The return movement begins in April and is usually completed by the end of that month. Spawning takes place during February, March, and April in the waters around the Isle of Man and off the Cumberland coast. The young immature fish remain in these waters throughout the year.

The second paper, by Prof. Jas. Johnstone, gives an account of the cod as a food fish. It contains a summary of most of the results of analyses of cod and cod products, which may be found in König's big volume and in the work by Atwater. The results obtained from Irish Sea cod are also included. The results show that the cod is a "fat-poor" fish. Less than about half of the total weight of the entire fish is edible. In the edible substance, about 81 per cent. to 84 per cent. is water, and there is practically no fat; about 1 per cent. is ash, and the rest (about 14 to 17 per cent.) is protein.

The third paper, by Prof. Johnstone and Mr. A. Scott, summarises information on the parasites and diseases of the cod. Ectoparasites and endoparasites are set out under orders and families, and a note on the occurrence of each is given. Both are less numerous in the cod than in many other species of fishes. The whiting and haddock, for example, are much more affected than is the cod. Cases of sarcomatous and other tumours, lupus and ulceration of the body, "columnar disease" in the muscle, diseased liver, stone in the urinary bladder, and ovarian degeneration are on record. Humpbacked cod in which the head is fairly normal in shape, while the trunk and tail regions are shortened and the backbone is thrown into a gently spiral form, are occasionally seen. One-eyed cod suggestive of irregular development rather than of injury are also recorded. References to literature on hermaphroditism are given in the concluding section of this instructive paper.

University and Educational Intelligence.

ABERDEEN.—Prof. Alex. Findlay has accepted an invitation to visit Stanford University, California, as acting-professor of chemistry for the three-quarters of the academic year, January to August, 1925.

LEEDS.—The University and the Philosophical and Literary Society have arranged a joint programme of lectures and music for the autumn term. The lectures include one by Prof. L. Bairstow on some aspects of modern aerodynamics, one by Mr. J. S. Huxley on recent progress in developmental physiology, and three by Prof. A. Gilligan on the geology of Yorkshire, all of which are free. Prof. S. Brodetsky and Mr. S. Stoneley are giving a popular course of six lectures on astronomy and Prof. P. F. Kendall three lectures on man and the ice age.

LONDON.—The two following courses of free public lectures at King's College are announced:—On Wednesday, October 8, and seven successive Wednesdays, at 4.30, "The Histology of the Nervous System," by Dr. C. da Fano; on Wednesday, October 8, and four following Wednesdays, at 5.30, "The Human Body and its Function," by Prof. R. J. S. McDowall.

On Friday, October 3, at 5.30 P.M., Prof. T. Percy Nunn will deliver a free public lecture at University College on "The Scientific Interpretation of Nature." This lecture is introductory to the new course for the M.Sc. on the principles, history, and method of science.

APPLICATIONS are invited for the headship of the chemistry department of the Borough Polytechnic Institute. Particulars and a form of application are to be obtained from the principal of the Institute, Borough Road, S.E.1.

IT is stated in the *Times* that schools of forestry are to be established at the University Colleges of Auckland and Canterbury by the New Zealand Government, which will make a grant of 1000*l.* a year, with an additional 600*l.* towards the cost of initial equipment.

INDIAN education in 1922–23 is reviewed by the Educational Commissioner with the Government of India in a report recently published at Calcutta. Commenting on the reorganisation of the University of Allahabad, the report states that some dissatisfaction has been expressed with the arrangement by which a residential teaching university is combined with affiliated colleges, some of which are situated at places very far distant from the university centre. This has led to movements for the establishment of universities at Agra and in Rajputana.

WE have received a "London University Guide and University Correspondence College Calendar, 1924–25," issued by University Correspondence College, Burlington House, Cambridge. This is a handy little volume of 200 pages, giving in convenient form regulations, syllabuses, and advice as to appropriate text-books for preparation for the matriculation and external degree examinations of the University of London. It is issued gratis. It was formerly published annually, but its issue has been suspended since 1915.

THE London County Council recently opened an education publicity campaign by issuing an excellent little pamphlet entitled "The Londoner's Education." This has now been followed by a sixpenny "Guide to Continued Education in London," this being No. of a "Privileges of Citizenship" series. In additi to giving a concise account of the provision ma for continuation education of all types—commerci technical, trade, domestic, literary—and of t facilities available for all classes of students f improving their knowledge and using profitab their leisure hours, the booklet gives lists of numero pamphlets, obtainable, most of them gratuitousl at the Council's offices, which contain more detail information. It gives also a convenient list several hundreds of institutions offering eveni classes.

THE Ministry of Agriculture and Fisheries and t Board of Agriculture for Scotland are inviti applications for a limited number of agricultur scholarships, of a maximum annual value of 200 which are open to students proposing to take up pos as agricultural organisers, teachers or lecturers agriculture, etc. Candidates should usually graduates of a university. The scholarships a tenable for two years, and are intended to gi students an opportunity of broadening their kno ledge of agriculture both at home and abroad. The value will vary according to the scholars' means, a to the cost of living prevailing in the country visite laboratory fees and travelling expenses will be d frayed. Particulars may be obtained from t Secretary, Ministry of Agriculture and Fisheri 10 Whitehall Place, London, S.W.1, in the case English and Welsh students, and from the Secretar Board of Agriculture for Scotland, York Buildin Queen Street, Edinburgh, in the case of Scotti students. The latest date for receiving applicatio is October 31.

THE Industrial Fellowship scheme of the Mell Institute of the University of Pittsburgh has been operation for thirteen years. A recent report of t director shows that at the close of the year 1923– no fewer than 83 research chemists and engineers we employed at the Institute, and that the sum 412,132 dollars had been contributed for sustaining th work by the industrial fellowship donors. The tot amount of money given by industrial firms to t Institute since 1911 is 2,719,103 dollars. The histo and research system of this unique institution are d scribed in an illustrated booklet, which also contai one of the forms of agreement under which fellowsh foundations are accepted. The salient features the system are as follows: A firm or an associati of manufacturers having a problem or group problems that needs investigation, provides a sum money (about 5000 dollars for each investigator to employed for a whole year) sufficient to cover salari of investigators, operating charges, and purchase necessary equipment; the Institute selects the fell or fellows, and furnishes laboratory, library, co sultative facilities, the use of its permanent resear equipment, direction to the progress of the work, a an environment that stimulates productive investig tion; all results are the property of the donor, whom in the meanwhile monthly progress reports a regularly submitted. Although primarily an i dustrial experiment station, the Institute recognis the need of fundamental scientific research as a bac ground and source of stimulus for industrial researc and has funds which are devoted to the prosecution investigations not suggested by industry but plann by the permanent staff, four of whom were engag in purely scientific research of this type during t year. Co-operation between the fellows is stimulat by a social club, in the activities of which all a expected to take part.

Early Science at the Royal Society.

September 27, 1662. The president communicated ...tter sent by his majesty to the duke of Ormonde, ...-lieutenant of Ireland, recommending the Royal ...ety for a liberal contribution from the adventurers ... officers of Ireland for the better encouragement ...he said society in their designs. Whereupon it ... ordered that a copy of the said letter should be ...n; and the humble thanks of the society be ...rned to his majesty by Sir Robert Moray, for ...th great testimony of his royal favour.—The presi... was desired to return likewise the thanks of the ...ety to Mr. Secretary Nicholas and Mr. Williamson, ...their readiness to assist the society in the king's ...ers to Ireland without taking fees.

September 28, 1664. There was read a letter of ... Wallis to Mr. Oldenburg, giving an account of his ...ing performed the task imposed upon him con...ing Mr. Horrox's astronomical papers, by com...ing the copies with the originals, and digesting all ...several pieces into one body, and prefixing to it ...epistle addressed to the president of the Society.—... secretary informed the Society that at Rome ...ervations of Jupiter had lately been made with ...new glasses of Campani, by means of which, six ...ts had been discovered in that planet, four of ...ich had appeared more obscure, and two more ...ir than the rest of his body.—The secretary ...ing also formerly written to his correspondents in ...nce, to inquire into the truth of the odd experi...nt delivered by the jesuit Casati, in his book, ...ituled, "Terra machinis motu," and received an ...wer thereto by a person who had consulted the ...hor of the book himself concerning the same, he ...nmunicated it to the Society; the substance of ...ich was that the said Casati had not tried the ...periment himself, but had seen it tried by a ...ntleman, named Don Innocenzo Conti, viz., that the ...uor extracted out of a certain bismutum, and well ...tified, when sealed up hermetically, and exposed ...the moon, rose in the full, and fell in the new moon.

September 30, 1663. Mr. Palmer presented the Society, ...m Mr. Edward Diggs [Digges] with two sorts of silk, ...e coarse, the other fine, sent from Virginia, and ...ade there; together with some written observations ...Mr. Diggs' concerning silk-worms, and the making ...silk, contrary to the received opinion thereof. Mr. ...lmer was desired to return the Society's thanks to ...e presenter, and to let him know, how much they ...re pleased with his care and concern for improving ...this manufacture; and how glad they should be to ...ceive information, from time to time of the progress ...it. Mr. Hill was desired to get the parcel of the ...arser silk to be put into a stuff for a cover for the mace.

1674. Mr. Hooke reported, that upon his making ...e proposal of the council to Mons. Papin of twenty ...unds a year certain for writing all letters for the ...ciety, he had accepted the same.

October 1, 1662. Dr. Wren presented some cuts ...ne by himself in a new way of etching; whereby, he ...id, he could almost as soon do a piece on a plate of ...lass, as another should draw it with a crayon on ...per.—Dr. Merret read his paper concerning the ...anting and preserving of timber; together with his ...llection of those statutes, that have been formerly ...ade by the parliament of England.

October 3, 1666. The lord bishop of Exeter being ...quested to communicate the observations of ...piter's satellites made by Mr. Laurence Rooke in ...der to the calculating of tables of their motion, his ...rdship desired, that he might be put in mind of it ...Mr. Hooke, and that he would purposely come to ...s library in Gresham College to look them out.

Societies and Academies.

LONDON.

The Institute of Metals (Autumn Meeting), September 9.—R. J. **Anderson** and E. G. **Fahlman**: A method for measuring internal stress in brass tubes. The method for measuring longitudinal internal stress is called the strip method, and is carried out by slitting a narrow strip longitudinally in a piece of tubing; for example, a strip 2·75 inches long and 0·10 inch wide in a 3·25 inch tube length; and then releasing one end of such a slit strip by cutting. Stress is indicated by the springing out of the freed end, and can be calculated from the modulus of elasticity of the material and the distance in movement of the freed end.—D. H. **Andrews** and J. **Johnston**: The application of the ideal solubility curve to the interpretation of equilibrium diagrams in metal systems. The method of plotting here discussed has not been applied previously to metal systems. In many systems the simple theory fits the observations better than had been anticipated, and may at least be used as a guide in criticising and simplifying experimental work.—Guy D. **Bengough** and R. **May**: Seventh report to the corrosion research committee of the Institute of Metals. The problem of corrosion is considered largely from the point of view of the "scale" of corrosion products which forms on the surfaces of such metals as copper, zinc, and brass immersed in sea-water. A large proportion of tube failures in modern condensers is due to local impingement of aerated sea-water; the rapid corrosion is due to the local removal of protective scale by the impinging stream. Certain types of preformed scales may be very resistant to this type of action. The occurrence of "dezincification" is due, not to bad mixing of copper and zinc in the manufacture of brass, but to the absence of arsenic from tubes. The electrolytic method of protection of condenser tubes generally gives negative results, but occasionally good results have been reported; these seem to be due to chance secondary effects particularly of the anode products. Corrosion of brass may be due to metal-ion concentration cells or oxygen-distribution cells. With high-speed water streams the metal-ion concentration cell may become the more powerful and render the metal anodic and severely corroded; deposits of sand, porous masses of corrosion products, etc., may cause oxygen distribution cells to become active and set up local corrosion, but the most rapid cases of corrosion seem to belong mainly to the former type. Sometimes the two types of action reinforce one another.—E. H. **Dix**, Jr., and A. J. **Lyon**: Comparative results on copper-silicon-aluminium and other aluminium alloys as obtained on separately cast specimens and specimens cut from a crankcase casting. Copper-silicon-aluminium alloy is particularly well adapted for complicated castings which do not require a large amount of machining. The casting properties of Alpax are similar, but it has a very low proportional limit and is inferior in this respect. Lynite 195 has uniform and desirable physical properties. The proportional limit is considerably above any of the alloys tested. The foundry practice, however, is more difficult for this type of an alloy. 8 per cent. copper-aluminium alloy is suitable for the general run of castings and can be cast in sections $\frac{3}{16}$ in. or more in thickness without much difficulty.—R. **Genders**: The extrusion of brass rod by the inverted process. Precautions are necessary to secure good surface, the method adopted for the present being the avoidance of entrance of the skin of the billet into the region of flow. The structure of the extruded rod does not show the concentric zones of

material varying in crystal size and physical properties often produced by the peculiar nature of the flow which obtains in the ordinary process. The rear portion of the rod is variable in structure and hardness from centre to outside, but in a continuous gradient. All possibility of "core" defect is excluded, and, if defects are allowed to arise, they will be visible on the surface of the rod.—D. **Hanson** and Grace W. **Ford**: Investigation of the effects of impurities on copper. Part II.—The effect of iron on copper. Solid copper will dissolve about 4 per cent. of iron at 1100° C., but the solubility at lower temperatures is much less. Within the limits of solid solubility, the electrical resistivity increases rapidly as the iron content is raised: hence iron is extremely deleterious in copper for electrical purposes. The tensile strength is raised by 2 per cent. of iron from 14·5 tons per sq. in. to about 20 tons per sq. in. The effect of heat-treatment is relatively small. Iron has no great embrittling effect.—Sir Thomas K. **Rose** and J. H. **Watson**: Experiments on the working of nickel for coinage. The experiments were made in order to determine the conditions in which nickel for coinage could be cold-rolled in the existing rolls at the Royal Mint. It was found impossible to prepare coins containing 99 per cent. nickel with 1 per cent. of manganese, magnesium, carbon, iron, silicon, etc., such as are manufactured with the aid of hot-rolling. By the addition of 2 per cent. manganese, however, castings can be prepared suitable for cold-rolling and conversion into coin. The coins consist of a solid solution, and accordingly resist tarnishing and corrosion equally well with those containing 99 per cent. or more of nickel, such as are in circulation abroad.

Official Publications Received.

Transactions of the Leicester Literary and Philosophical Society; together with Report of the Council for 1923-1924 and Annual Reports of the Sections. Vol. 25, 1924. Pp. 55. (Leicester.)

Far Eastern Association of Tropical Medicine. Transactions of the Fifth Biennial Congress held at Singapore, 1923. Edited by the Hon. Dr. A. L. Hoops and Dr. J. W. Scharff. Pp. 974+86 plates. (London: J. Bale, Sons and Danielsson, Ltd.) 40*s*. net.

Memoirs of the Asiatic Society of Bengal. Vol. 8, No. 2: The Prakrit Dhātv-ādeśas according to the Western and the Eastern Schools of Prakrit Grammarians. By Sir George Abraham Grierson. Pp. 77-170. (Calcutta.) 3.15 rupees.

The Rockefeller Foundation: International Health Board. Tenth Annual Report, January 1, 1923-December 31, 1923. Pp. xvii+158. (New York: 61 Broadway.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 76: Studies in the Dermaptera and Orthoptera of Ecuador. By Morgan Hebard. Pp. 109-248+plates 5-10. (Philadelphia.)

Government of India. Department of Industries and Labour: Public Works Branch. Irrigation in India: Review for 1922-1923. Pp. iv+89. (Simla: Government of India Press.) 12 annas.

Forest Bulletin No. 58: General Volume Table for *Chir* (*Pinus longifolia*). Classified by Diameter (and Girth) and Height. By S. H. Howard. Pp. 14+3 plates. (Calcutta: Central Publication Branch.) 8 annas.

Report on the Danish Oceanographical Expeditions 1908-10 to the Mediterranean and Adjacent Seas. Vol. 2: Biology. H. 1: Medusæ. By P. L. Kramp. Pp. 67. (Copenhagen: Andr. Fred. Høst and Søn.)

The Hundred and Second Report of the Commissioners of His Majesty's Woods, Forests, and Land Revenues. Pp. 50. (London: H.M. Stationery Office.) 6*s*. 6*d*. net.

Prospectus of University Courses in the Municipal College of Technology, Manchester, Session 1924-25. Pp. 229. (Manchester.)

Meddelanden från Statens Skogsförsöksanstalt. Häfte 21, Nr. 4: Några Norrländska Skogsföryngringsproblem II; Quelques problèmes relatifs à la régénération dans la Suède septentrionale II. Av Gunnar Schotte. Pp. 149-180. Häfte 21, Nr. 5: Tallens och granens Kolsyreassimilation och dess Ekologiska Betingelser; Untersuchungen zur Ökologie der Kohlensäureassimilation der Nadelbäume. Av M. G. Stålfelt. Pp. 181-258. Häfte 21, Nr. 6: Skogsinsekternas Skadegörelse under åren 1919-1921; Die Schädigungen der Forstinsekten in den Jahren 1919-1921. Av Ivar Trägårdh. Pp. 259-294. (Stockholm: Centraltryckeriet.)

Loughborough College, Leicestershire. Calendar, Session 1924-25. Pp. xiv+214+53 plates. (Loughborough.) 3*s*. 6*d*. net.

Transactions of the Institution of Chemical Engineers. Vol. 1, 1923. Pp. xv+120. (London: Abbey House, Westminster.)

Manchester Astronomical Society. Journal of the Sessions 1922-1924. Pp. 60. (Manchester.) 4*s*.

Growth in Trees and Massive Organs of Plants. Dendrographic Measurements, by D. T. MacDougal; The Growth Record in Trees, by Forrest Shreve. (Publication 350.) Pp. 116. (Washington: Carnegie Institution.) 1.50 dollars.

Department of Marine Biology of the Carnegie Institution of Washi... Vol. 20: American Samoa. Part 1: Vegetation of Tutuila Island; P... Ethnobotany of the Samoans; Part 3: Vegetation of Rose Atoll... Prof. William Albert Setchell. (Publication 341.) Pp. vi+27... plates. (Washington: Carnegie Institution.) 3.50 dollars.

The Vesuvius Eruption of 1906: Study of a Volcanic Cycle... Frank A. Perret. (Publication 339.) Pp. 151+24 plates. (Washin... Carnegie Institution.) 4 dollars.

Natal Museum. Mammals, Series 1. 10 pictorial post card... leaflet. Mammals, Series 2. 10 pictorial postcards and leaflet. (P... maritzburg.)

Year Book of the Michigan College of Mines, 1923-1924, Houg... Michigan. Announcement of Courses, 1924-1925. Pp. 123. (Houg... Mich.)

Department of Commerce: Bureau of Standards. Technologic P... of the Bureau of Standards, No. 259: Saturation Relations in Mi... of Sucrose, Dextrose, and Levulose. By Richard F. Jackson and ... Gillis Silsbee. Pp. 277-304. (Washington: Government Printing O... 10 cents.

Bulletin of the American Museum of Natural History. Vol. 49, A... The Dermaptera of the American Museum Congo Expedition; w... Catalogue of the Belgian Congo Species. By James A. G. Rehn. ... 349-413. Vol. 49, Art. 4: Size-Variation in Pyrenestes, a Genus of We... Finches. By James P. Chapin. Pp. 415-441. Vol. 49, Art. 5: Obs... tions on *Colobus* Fetuses. By Adolph H. Schultz. Pp. 443-457. ... York.)

Marine Structures: their Deterioration and Preservation. Rep... the Committee on Marine Piling Investigations of the Divisi... Engineering and Industrial Research of the National Research Co... By William G. Atwood and A. A. Johnson; with the Collaborati... William F. Clapp, of Robert C. Miller, and of H. W. Walker, ... McQuaid and Marjorie S. Allen. Pp. vi+534+14 plates. (Washin... National Research Council.) 10 dollars.

Diary of Societies.

SATURDAY, SEPTEMBER 27.

SCHOOL NATURE STUDY UNION (Anniversary Meeting) (at Londor... Training College), at 3.—G. H. Gater: Address.

TUESDAY, SEPTEMBER 30.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. Lamb: Marin... Engines, Practical Notes on Bearing Adjustment.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. ... Rodman: A Talk about Orchids.

WEDNESDAY, OCTOBER 1.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMIS... Chemical Society), at 8.—G. D. Elsdon and P. Smith: The Deter... tion of Coconut Oil and Butter Fat in Margarine.—F. Knowle... J. C. Urquhart: A Preliminary Note on the Composition of the ... Goat's Butter.—Miss W. N. Nicholson and D. Rhind: The Quanti... Estimation of the Degree of Hydrolysis of Gallotannin by Tann... Miss M. B. Richards and W. Godden: The Pemberton-Neumann M... for the Estimation of Phosphorus.—W. S. Shaw: Applicati... "Formal Titration" to the Kjeldahl Method of Estimating Nitro...

THURSDAY, OCTOBER 2.

INSTITUTION OF MINING ENGINEERS (Annual General Meeting) (at B... Empire Exhibition), at 11 A.M.—Dr. J. S. Haldane: The Valu... which the Institution stands (Presidential Address).—Sir J... Court: Salt Treatment for Miners' Fatigue.—Prof. K. Neville ... (*a*) The Food Requirements of Coal Miners; (*b*) The Mecha... Efficiency of the Human Body during Work in High Air Temperat... (*c*) The Physiological Standardisation of the Kata-Thermometer.—... Storrow and J. Ivon Graham: The Application of Gas Analysis t... Detection of Gobfires.

ROYAL AERONAUTICAL SOCIETY, at 5.30.—Lt.-Col. H. T. Tizard: Co... Sense and Aeronautics.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss I... Ward: Speech Defects.

FRIDAY, OCTOBER 3.

INSTITUTION OF MINING ENGINEERS (Annual General Meeting) (at B... Empire Exhibition), at 10.30 A.M.—E. Williams: Economics o... Coal-mining Industry.—R. L. A. Dron: The Valuation of Mines... Minerals, and the Relation of Income Tax to such Valuations.—... D. Hay and R. Clive: The Ventilation of Mines.—E. L. Hann: ... Rhymney Valley Compressed-air Installation.—S. Mavor: Proble... Mechanical Coal-mining.—F. S. Sinnatt and H. E. Mitton: The ... paration of Coal for the Market.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Displ... Exhibition Slides.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Prof. A. W. Bicke... Explosions, Terrestrial and Celestial.

PUBLIC LECTURES.

THURSDAY, OCTOBER 2.

UNIVERSITY COLLEGE, at 2.30.—Sir Flinders Petrie: The Official Cl... of Ancient Egypt.

FRIDAY, OCTOBER 3.

BEDFORD COLLEGE FOR WOMEN, at 11 A.M.—Miss Hosgood: The Ne... lands.

UNIVERSITY COLLEGE, at 5.30.—Prof. T. Percy Nunn: The Scie... Interpretation of Nature.

NATURE

SATURDAY, OCTOBER 4, 1924.

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Editorial and Publishing Offices :

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Psychologists and Examiners.[1]

THE idea is prevalent in Great Britain that no government department will accept a new thing until it has become hoary with age. The Consultative Committee of the Board of Education has disproved the generality of the truth of this idea by the acceptance of a view which dates from the present century, and it has at the same time proved its common sense by refusing to endorse a proposition which is held true by the experts who are in a position to decide, but is not sufficiently established for non-experts to be convinced of the truth of it.

The thing the Consultative Committee accepts is the value of intelligence tests for use at the beginning of each stage of school education for the purpose of sorting out the children fit to profit by further education from those who are not fit. Such tests were used last century for ascertaining mental deficiency, but their use for the normal child first became a possibility twenty years ago when Prof. Spearman showed how numerical measures could be obtained by means of the coefficient of correlation. The approval of the Consultative Committee will lead to the rapid extension of the use of these valuable tests, which hitherto have been applied only sporadically in Great Britain.

The proposition which the Committee refuses to endorse is that there is a "general ability" which takes part in the various activities of the mind, and usually takes an important part. The use of numerical measures for psychological quantities soon brought Spearman to realise the existence of this general ability, and his writings on the subject are conclusive to readers who understand the calculation of a correlation. For the Committee to accept this proposition would have meant simply that it accepted the dictum of the experts and that it was not its own conclusion. Such acceptance is impossible for a committee the opinion of which is to carry weight, and the refusal to endorse the proposition is evidence that any conclusions it does accept are its own and thus gives these conclusions increased weight. We do not, of course, mean that the members of the Committee are not experts; we mean that although they are all experts in education, they have not the particular expertness wanted for this question. The attitude towards intelligence tests shown by men with no special knowledge even of education was exemplified by the House of Commons when that body, so wise in ordinary matters, imagined that it had finally disposed of intelligence tests by the invention of the term "jazz papers" amid Rabelaisian laughter; and by the Southborough Committee, which

[1] Report of the Consultative Committee of the Board of Education on Psychological Tests of Educable Capacity and their Possible Use in the Public System of Education. Pp. xii+248. (London: H.M. Stationery Office, 1924.) 2s. net.

also condemns them and adopts the scornful House of Commons term.

If we wish to estimate the value of any method of testing, we must first be clear about the object for which the test is to be used. The object the Consultative Committee has mainly in view is the testing of educable capacity, that is to say, the discrimination between children fit to undergo a further stage of education and those unfit to do so; and the discussion of this problem is sound. The Committee is, however, strangely blind to other purposes for which examinations may be held. Thus, for example, it looks on the First and Second School Examinations as the end of all things rather than as a test of fitness for a career or for admission to a university.

The tests that came under the consideration of the Committee may be classified as follows :

1. Tests of inborn qualities such as (*a*) general ability; (*b*) special ability, including aptitudes for particular vocations; (*c*) personality, including temperament and will.

2. Attainment tests which gauge the degree to which the examinee has benefited by his education.

3. Physical qualities which, if their investigation is found worth pursuing, will be found to subdivide into inborn qualities and acquired qualities.

These tests fall to be considered for their value for (1) entrance to an educational stage, (2) entrance to life work.

Of the tests we have enumerated, the Committee deals rapidly with all but the tests of general ability. It considers that tests of special ability and of personality may possibly have value, but that much development is necessary before it can recommend them for general use.

The approval by the Consultative Committee of the use of psychological tests of general ability is given on the understanding that :—(1) The object is to test educable capacity. (2) Elements of personality, such as temperament and will, must also be taken into account. (3) The possibility is to be kept in mind that a particular temperament or kind of will may upset the results and vitiate them as a measure of educable capacity. (4) The psychological tests now in use bring out results too high in the case of the verbalist (who is especially skilled in language), and too low in the case of the non-verbalist, in whose case justice requires the application of other tests such as performance tests. (5) The questions must be framed with proper regard to the child's environment, so that, for example, urban questions must not be set to the rural child.

It is well for us to consider what guidance we can find in the report for other purposes, as, for example, for School Leaving Examinations and First School Examinations, and for examinations used by a business firm to choose its employees. For the business in the answer is clear. In addition to a reasonable of general knowledge and a suitable personality candidate must possess an appropriate grade of ge intelligence. The older fashioned examination and often does, test intelligence incidentally, but it not discriminate between intelligence and other ties and determine the degree of intelligence a cand possesses. The psychological test does so, and is on account valuable to the business firm.

The School Leaving Examination appears in main to be an attainment test held for the purpo ascertaining what the school has done for the pupil this is its object, the psychological test seems to ha place in it. Indeed, so far as the examination ha object of measuring the diligence which the boy o has shown, it might even be held that general in gence should be discounted on the ground that b help the cleverer pupil of little diligence makes as a show as the less clever but very diligent pupil. O other hand, so far as a school examination serv a university entrance examination, it should re such intelligence as is necessary to undertake st of a university grade.

It is clear, then, that the value of the psycholo test for a School Leaving Examination can be de only after the true object of the examination has determined. The question of the true object sh accordingly be among the first references to the committee, the appointment of which is recomme by the report before us.

The value of the psychologist in intelligence te proved. In attainment tests, that is, in the tes knowledge such as are conducted by the older exami bodies, there is need for co-operation between psychologist and the old-fashioned examiner. schemes of these examinations must be worked ov see whether the psychologist can improve them. give an example, the old examiner, when he found the examination results from two subjects ranged candidates in very much the same order of m argued from this fact the excellence of the two ques papers ; the psychologist offers an alternative expl tion, namely, that the two tests measure much the s qualities ; and this explanation must lead us to sider whether it would not therefore be sufficien employ one of the question papers and drop the ot

On the other hand, the psychologist must remen that the region of attainment tests is not virgin The old-fashioned examining bodies have been at w for long periods, and, although equipped only common sense in place of psychological knowle have attained conclusions which may require s adjustment but are likely to remain valid.

ne idea that requires discussion between the old aminer and the psychologist is that of the "short swer," usually consisting of a single word. The idea of he "short answer" seems to have been transferred, thout much consideration, from the intelligence test to he attainment test, and it is for the psychologist to nish evidence as to the circumstances in which a stion paper framed on these lines is better than the stion paper usual in Great Britain, in which a candie has three hours to answer half-a-dozen questions, l better than the customary French examination per in which three hours are devoted to a single stion.

The use of the competitive interview is quite recent l the experience of it slight. It has not yet had time be standardised. It is a problem on which the old aminer and the psychologist ought to co-operate, the dible point of view being even more valuable here n in long-established tests.

The Chemist as Propagandist.

e Heavy Chemical Industry. By Rex Furness. Pp. 28. *Fine Chemicals.* By T. W. Jones. Pp. 20. *Wood Products.* By T. W. Jones. Pp. 19. *The Quest for Colour: a Short Survey of the Story of Colour in Relation to Man's Needs and Achievement.* By Dr. A. T. de Mouilpied. Pp. 31. *Chemists and their Work.* By Stephen Miall. Pp. 19. *The Fermentation Industries.* By Rex Furness. Pp. 19. *Chemistry in the Manufacture of Pigments, Paints and Varnishes.* By C. A. Klein. Pp. 24. *Chemistry in Relation to Food.* By Dr. G. W. Monier-Williams. Pp. 20. (Chemical Industry Pamphlets.) (London: Ernest Benn, Ltd., 1924.) 6*d.* net each.

FEW of us consider that we occupy the exalted positions which Nature or a benevolent Providence intended us to fill, and none, except perhaps the uly meek, hesitates to use legitimate agencies for rthering his advancement. Scientific workers are exception to this rule, and of late they have been veloping a "class consciousness," and organising emselves into associations that correspond in certain atures to the trades unions of the proletariat. lthough they have their differences of opinion, those ho depend upon science for their daily bread are nanimous in thinking that their position in the social ale is unduly low and incompatible with the value their work for the community. The worker in pure nd applied chemistry does not lag behind the rest. His picturesque forerunner, the astute alchemist, layed on the whole an ignoble part in administering the acquisitiveness of kings and courtiers; and the odern industrial chemist keeps up the tradition by selling his services to employers whose main ambition is to transmute materials and labour into gold: he seldom occupies a commanding position either in the industrial or the social world.

It may, however, now be said that chemists have passed through the first stage in their social evolution, inasmuch as they are fully cognisant of their unmerited inferior status. They have entered upon the second stage, which is combination for a common purpose; but they have yet to negotiate the difficult final stages, which comprise the selection of competent leaders and the conversion of their fellow-citizens. The chemical world has never been rich in men possessing the human qualities needed for effective leadership, and the task of selection is by no means easy; for the chemist is not only by nature an individualist, he is also a born rationalist, neither exhibiting emotion nor being influenced readily by it.

To convince the man in the street of the vital importance of chemistry, and inferentially of the vital importance of the chemist, is also difficult, as the means available for this purpose are limited. Chemistry, like most of the other sciences, is taboo to the editor of the popular newspaper and to the popular author; actors, preachers, politicians, prominent soldiers and sailors fight shy of it (though some of them may accept seats on the boards of chemical companies). It was, therefore, a good idea that prompted the Association of British Chemical Manufacturers and the Society of Chemical Industry to bring out a series of popular prints on chemical topics in connexion with the British Empire Exhibition, and all chemists will bless them if the seed they are sowing falls on fertile soil. The success of such propaganda must, obviously, depend not only on the nature of the material selected, but also on the manner in which it is treated; and this consideration impels one to comment on popular scientific literature in general.

Comparisons are sometimes drawn between the good old days when Huxley and Tyndall drew large audiences of working men and others to their popular lectures and wrote essays that were widely read, and the present time when the demand for such work is very poor. With all respect, nay, veneration, for these great expositors, it is doubtful if they would achieve to-day the same success that they won thirty to fifty years ago. The world has become more material and sensation-loving, so that a new method of attack seems imperative. A successful popular writer of to-day must understand the psychology of his readers and adapt his style to the nature of his audience. Now this is not an easy proposition, particularly for the writer of science, because, from the point of view of scientific knowledge, the man in the street is not one abstract individual but

several. For the present purpose, he may be conceived either as a man who is totally ignorant of and completely indifferent to science, or as one who learnt sufficient at school or elsewhere to realise dimly its importance. The former type is in a great majority, and it is mainly he who must be attracted and impressed. How can we approach him? What kind of reading does he prefer? The answer to the latter question is well known and writ large at the top of the columns of his daily newspaper: anything that appeals to his primitive instincts. Personalities and abnormalities, matters relating to material gain, sex, sport, fighting, and adventure: these are the main excitants. Emotion, not reason, being the keynote of his mental disposition, he must be approached through his affects. Unfortunately, the writer of popular science has only a few instincts to play upon, such as wonder, acquisition, and construction, but if he is skilful he can turn these to good account. (In this connexion it is noteworthy that the scientific topics that have been most reported of late are, Mars—mercury from gold—wonders of wireless—determination of sex.) Further, our man in the street dislikes being preached at. He has little regard for unembellished statements of fact: he must see their bearing, actual or potential, on his daily life. For historical data he does not care, and of abstract thought he is usually quite incapable. So far as possible, things must be presented to him in concrete and predigested form. Hence the language to be addressed to him must be simple, concrete, and familiar; technicalities must be avoided, sentences should be short, and headings numerous.

If these comments and desiderata be conceded, only one general conclusion can be drawn concerning the pamphlets under notice: they are unlikely to appeal at first sight to the individual whose mental attitude has just been outlined. On the other hand, they should certainly be appreciated by the minority who have already a bowing acquaintance with science. As might be expected, there is a considerable diversity of merit, and it is not easy to generalise. It may, however, be said that the authors have succeeded in demonstrating the innumerable ramifications of chemistry and the ubiquity of the chemist. The most common defect is that the authors have attempted to tell too much: they have fired their facts straight at the reader as from a machine-gun, whereas they should have propelled them at an angle, like star-shells, to burst at intervals and illuminate the scene. Further, they have not made enough of the human factor, and have not appealed sufficiently to the wonder instinct of their readers. In some cases the composition is defective; the golden rule to use the concrete noun and the active verb wherever possible has been neglected, and windy circumlocutions are numerous. we read: "The cultivation of these plants is p cuted" [These plants are cultivated]; "A great am of careful consideration" [Much careful thou "Titanium dioxide has remarkable opacity, and feature is utilised in its employment for pig purposes" [Titanium dioxide is remarkably op and therefore very useful for making pigments]; " platinum acts as a catalyst . . . without sen alteration to its own character" [. . . without u going change].

The pamphlet entitled "The Quest for Colour" far the most attractively written; its author s literary gifts, not the least of which is imagina and he makes skilful use of analogy and allusion. has selected his material with excellent judgment not overburdened his interesting story with a multi of superfluous facts, and he has written an essay w every educated man, whether he have knowledg chemistry or not, will delight in reading. Of a diff and more academic type is "Chemistry in Relati Food," the author of which has made full use o intimate relation of his subject to everyday life. has wisely omitted historical references, and th he has produced rather strong meat for the ge reader, his matter is very interesting and well b out the value of chemistry in safeguarding the p of our food supplies. "Chemists and their Work somewhat disappointing, as one hoped—per wrongly—to find in it some pithy remarks on psychology of the chemist; and the opening state that "Chemistry is the key to modern prosperit modern civilisation" is too bombastic even for E bition literature. The author has, however, succe in conveying his information in simple language, his story, though somewhat sketchy, is distin readable. "Fine Chemicals" and "Wood Produ contain fluent accounts of these important mate which will be appreciated by those who already some knowledge of chemistry; and the same ma said of the pamphlets on "The Heavy Che Industry" and "The Fermentation Industries," w are bursting with information and written in too bose a style. Judicious pruning by the editorial would have greatly improved these two pamph The writer of "Chemistry in the Manufacture of ments, Paints and Varnishes" is an acknowle authority on these materials, and his articles are alw worth reading; but although he has many interes things to relate in his pamphlet, he cannot be sai show the gift of popular exposition.

It seems, therefore, as if the scientific worker is well fitted, either by nature or nurture, to play cessfully the part of propagandist to the man in

st et. He is usually too academic, too objective, too ch devoted to statements of fact and too little to ing. A popular appeal must be through the human rt and by the stimulus of the spirit of discovery. Is not necessary to adopt the specious methods of politician or the sensational style of the popular ss, but the gospel of science can be taught only by apostle who realises that " il ne s'agit pas de parler, 'agit de persuader ; il ne s'agit pas d'écrire sur du ier, il faut écrire dans les cœurs."

The Analysis of Sound by the Cochlea.

e Mechanism of the Cochlea : a Restatement of the Resonance Theory of Hearing. By George Wilkinson and Dr. Albert A. Gray. Pp. xx+253+4 plates. (London : Macmillan and Co., Ltd., 1924.) 12*s.* 6*d.* net.

THE means by which physical stimuli are converted into sensations are always the subject of controversy. So far as the recognition of the physical vents is concerned, it is undesirable that the intermediate processes should obtrude themselves on the observer's consciousness ; nevertheless, the mechanisms interpretation form a fascinating, though difficult, bject for a physiologist.

In order to understand the whole process, one must now the applications of physics to the subject of scussion, as well as have a sound knowledge of the inute anatomy of the interpreting organ, and of the ysiology of the nervous system.

Drs. Wilkinson and Gray have presented a readable tline of the mechanism of the cochlea. They quite ghtly exclude all hypotheses which place the mechanm of analysis in the brain. The presence of such a mplicated organ as the cochlea would be quite unecessary if the nerves merely conveyed a complicated eries of impulses corresponding to the waves of pressure the air, and so far as all physiological evidence goes, ne nerves are incapable of conveying impulses of such igh frequency as occur in sounds of high pitch. In fact, such hypotheses are merely a confession of failure o explain the mechanism.

Of all the analytical processes ascribed to the cochlea, he authors believe that the correct one is a resonator echanism. They point out that there is a progressive ifferentiation in the length and tension of the fibres of he basilar membrane, and in the load due to the liquid the cochlea from its base to its apex. Thus all the erms in the formula

$$\text{frequency} = \frac{1}{2 \times \text{length}} \times \sqrt{\frac{\text{tension}}{\text{mass per centimetre of length}}}$$

elp to make the basal end of the organ of corti resonate o high notes, and the apical end to low notes.

The authors commence by a description of the physics of sound and of the principles of resonance. This is followed by a brief outline of the evolution of the cochlea and a more detailed description of the mammalian cochlea. In the latter description one might expect to find some mention of the division of the basilar membrane into subarcuate (elastic) and pectinate zones, and some discussion as to the possibility of the rods of corti altering the periodicity of the resonating mechanism. Although the rods of corti are present only in mammals, they ought to have some influence on the analytical mechanism of those animals in which they are found.

Dr. Gray explains very clearly how it is possible that a note of a certain pitch can be recognised although the vibration of the organ of corti may be spread over a number of receptors : in fact, the more strongly stimulated receptors cause an inhibition of the sensations which might be produced by neighbouring less stimulated ones. One sees examples of such inhibition in other sensory mechanisms.

The authors doubt the adequacy of " sound picture " and " travelling bulge " hypotheses to explain sound analysis, and it must be granted that if the latter are to have any meaning, they resolve themselves into a process of localised movement of the basilar membrane corresponding to a resonance process ; otherwise, the distance that a wave travels up the cochlea should be a function of its amplitude and not its frequency.

Dr. Wilkinson describes the well-known model which he has made to illustrate the analysis of sound waves by a resonance system comparable to that of the cochlea, and the method of construction is given in an appendix. Such a model merely shows the possibility of the analysis by a corresponding resonance mechanism without proving that it is the only way in which the result can be obtained. The reviewer would point out that it is possible to differentiate frequencies of pressure waves by means of viscosity *in spite of* the inertia acting in the opposite direction. Thus, two tubes of the same length but of different diameters, united to a common tube, can be used. Pressure differences applied to the common end will cause movement of a contained liquid mostly in the wider tube, but if a small bulb closes the far end of the wider tube, and a large one the far end of the narrower tube, it will be found that low frequencies of pressure changes will cause most movement along the narrow tube, whilst high frequencies will cause most movement along the wider tube. The inertia for the same extent of movement should be less in the narrower tube, therefore this differentiation occurs in the reverse direction to what one would expect from the mass of liquid contained in the tube. It is in view of the fact that

friction may have some effect on the analysis of sound waves that the model described on page 104 differs from that of Lux and others. It may be true that viscosity has nothing to do with resonance, but there is a mechanism due to liquid friction by which analysis can be produced; this process may be supplementary to the factors discussed by Drs. Wilkinson and Gray.

The authors say nothing about the variations in area that occur along the scalæ of the cochlea, and these variations become significant in relation to viscosity effects.

This book should be read by all those interested in the problem of how sounds are analysed, and it gives a concise and adequate description of the various facts and hypotheses concerned in the action of the cochlea.

H. E. ROAF.

Diving in Birds.

The Bird as a Diver: a Contribution to the Natural History of Diving Birds. By Dr. John M. Dewar. Pp. xii+173. (London: H. F. and G. Witherby, 1924.) 10*s.* 6*d.* net.

DR. DEWAR has for many years been investigating in a quantitative way the problem of diving in birds, and more particularly the relation between the length of time spent under water and the depth of water. This book is a statement of his evidence and his conclusions.

The most important of these may be briefly summarised. The diving habit has been acquired independently several times over in birds. In spite of this, in five of the six families of birds studied by Dewar, the relation between time and depth is the same. Roughly speaking, it is 20 seconds for the first fathom of water, 10 seconds for each subsequent fathom. As a matter of fact, the data are more accurately represented by an S-shaped curve, with time as the abscissa. This, of course, is the curve of an autocatalytic reaction, and our author believes that the depth-time relation is determined by some autocatalytic reaction in the body. It is, however, equally legitimate (and more likely!) to suppose that there is some initial delay connected with "getting under way" subaqueously, and that below a certain depth each additional foot becomes more and more difficult. This would give a curve which, with the evidence here presented, it would be impossible to distinguish from the regular S-shaped curve of autocatalysis.

The coot alone, of all the birds studied (which included diving ducks, grebes, cormorants, divers, and auks), does not eat its food below water; it therefore has no "bottom time." The rough rule for the coot is 10 seconds for each fathom, including the first, but this species also shows the S-shaped curve.

From a study of the ratio between length of and length of pause, rate of increase of pause fathom of depth, and longest dive, it was possibl grade the diving birds for diving ability. The came out lowest, the auk highest, with the ot ascending in the order given in the preceding paragr

Numerous interesting points are brought out cerning under-water speed, greatest depth of (which is probably much less than is generally believ etc.; but the point which Dewar rightly empha as the most interesting is the fact that not merel similar but an identical time-depth relation has b independently evolved in at least five separate fam of birds under the influence of environmental similar

Although many will feel that a rather small si problem is here treated at somewhat excessive len the book is certainly a welcome contribution t scientific natural history, and shows what us biological work can be done by the field natura who is possessed of the scientific spirit and not of mere collector's instinct.

J. S. H

Regional Survey of Cambridge.

The Archæology of the Cambridge Region: a T graphical Study of the Bronze, Early Iron, Roman Anglo-Saxon Ages, with an Introductory Note on Neolithic Age. By Dr. Cyril Fox. Pp. xxv+36 37 plates+6 maps. (Cambridge: At the Univers Press, 1923.) 31*s.* 6*d.* net.

MAPS are the mainstay of this attractive volu on the antiquities dating from the later St Age to the Domesday Survey in a selected area, hav Cambridge for a centre. In a pocket at the end five tinted reproductions of the 1 in. Ordnance Sur map of nearly 2000 square miles, showing the distri tion of population and the natural features by wh that was determined in the various periods; there also sketch-maps in the text showing the relation this square to eastern England. These limits chosen not because they constitute a geographical u or area isolated by natural barriers, but because th include most of the localities which have furnished Archæological Museum of the University with mate here rendered accessible to students in more th the ordinary sense. The most interesting specim of the successive periods treated are represented 37 photographic plates, which have a home-ma appearance but are generally adequate, and bring light a good deal of new material. The text g further, and describes many finds preserved elsewhe but all part of the local story. Here, above all, author's industry and method are revealed and me general recognition, as the way is now indicated fo

si ilar treatment of other large collections. Seldom h e the utility and purpose of a museum been more p pably illustrated. Though much is gi o withheld—perhaps only temporarily. The region i ludes parts of Norfolk and Suffolk that swarm with f t implements, as the Neolithic map clearly shows; t this period is dealt with in 15 pages, and the Early S ne Age not at all. One has to confess that a Con- t ental work of this kind would have been better p portioned; and Cambridge has a mass of flint to i erpret to the world.

The careful study of museum specimens, the verifica- t n of their *provenance*, and the identification of others r t within the fold have led, as might have been ex- p cted, to important results; but the spade has many s surprise in store, and new light has recently been t own on the history of this part of England by the e cavation of the dykes or ramparts that form a series o barriers south of the Fens, and were evidently e ected against an inland people, as the ditch is to the s uth-west. Below the Fleam Dyke, for example, w re found Roman remains on the original surface; a d as there would have been no reason for such a work i the Roman period, it is now definitely referred to t e early Anglo-Saxon period and attributed to the E st Anglians, who did not trust their neighbours to t e west. Such vast earthworks can only have been c nstructed by large and organised communities; and t e next stage is to decide who were the people that t reatened to attack, and also at what moment the p sition became serious. History can here derive m uch assistance from archæology; and Dr. Fox has p inted out the military value of these lines across t e main road in open country between Newmarket a d Royston. Traffic flowed at right angles to this r ad in Roman times, and the crossing of two R oman highways was evidently the nucleus of C ambridge.

In striking contrast to the other four is the map of A nglo-Saxon settlements, on which the Domesday Vills a re uniformly scattered over what a few centuries before h ad been dense woodland on a clayey soil, difficult to c ultivate and dangerous to traverse. The same might b e thought to hold good of the Fens, but large areas i n the south-east of that formation were evidently i habited in the Bronze Age, and must therefore have s unk in the last 3000 years.

The work is planned on a generous scale, and Dr. F x's thesis has not only benefited himself but has also d one excellent service to the Museum with which he i s connected. It is no small achievement to have r alised the golden mean between the superficial guide- b ook and the voluminous and often unreadable cata- l gue. Museum curators, please copy.

Our Bookshelf.

A Textbook of Petroleum Production Engineering. By Prof. Lester Charles Uren. Pp. vii+657. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 30*s.* net.

Oil production, like oil geology or oil refining, has undergone rapid development in method and technique during the last few years, and the profession of the petroleum engineer, formerly one of somewhat uncertain definition, is fast becoming one of specialisation both in training and accomplishment. The industry has in the past relied on, and still to a large extent relies on, the services of practical field-men who, though they may have years of experience behind them, lack the requisite technical education enabling them to assume control of large-scale operations involving a competent knowledge of the science of oil production. The demand for qualified men of this description has brought about the establishment of systematic academic training at several universities, especially in America, and the author, himself a professor in the department of petroleum engineering at the University of California, has designed this work as a text-book of reference for students reading for this particular faculty.

The book thus presents to a larger audience the substance of theoretical and to some extent practical teaching of this phase of engineering, in accordance with the curriculum laid down at that university, and as an academic conception of the subject it is well done. The plan of the work is to trace the various stages of field-operations from preliminary exploitation through the ramified processes of drilling and production to transport and storage of petroleum, each of which is treated in great detail. Unfortunately, being an academic treatise of an intensely practical subject, the text reveals the atmosphere of the class-room rather than that of the field, with the result that the large amount of descriptive matter tends to be formal, stereotyped, and tedious to read, besides conveying (doubtless unintentionally) the suggestion of orderliness in actual operations which is far from being the case. Perhaps this is more noticeable in view of the fact that Suman's recent and excellent treatise on "Petroleum Production Methods" has, by its essentially scientific though practical point of view, set a standard as yet unattained by any other work of its kind, not excluding the present volume. To be really successful, a book such as this must give a lead rather than follow precedent; the student of the future, even more than the trained man of the present, will need inspiration as well as guidance, suggestion of possibilities rather than mere digestion of technical data. H. B. Milner.

Analytical Conics. By Dr. D. M. Y. Sommerville. (Bell's Mathematical Series: Advanced Section.) Pp. vii+310. (London: G. Bell and Sons, Ltd., 1924.) 15*s.* net.

We welcome Prof. Sommerville's book as one of the most comprehensive English treatises on analytical conics. The author shows a wide, detailed, and accurate knowledge of the subject, ranging from elementary co-ordinate geometry to chapters on systems of points on a conic and invariants. A student wishing to acquire a thorough knowledge of the subject cannot do better

than work steadily through the book, but one desiring a light course only will need much guidance in deciding what portions to leave out.

Various points require some slight alteration. In the early pages the notation 2, 2 instead of (2, 2), for the co-ordinates of a point, is unfortunate, as a beginner will have to unlearn it later. The classification of curves given by real equations of the second degree (p. 114) is incomplete, no mention being made of $m^2x^2+n^2y^2+1=0$. It should also be noted that $ab=h^2$ is not a sufficient condition for a parabola, and, on p. 247, that the algebraic freedom-equations must be rational. A few results are stated incorrectly, *e.g.* No. 12 on p. 255. Neither is the distance of a point from a line in homogeneous co-ordinates found in the best way.

However, these matters are only minor blemishes which can easily be adjusted in a later edition. Scientifically the weakest feature is the treatment of complex geometrical elements. Although the author lays stress on the fact that he has written about geometry, and not about algebra with a geometrical interpretation, he is content to say that a quadratic equation with unreal roots defines two "imaginary points" on a real line and to assign to these points the qualities of real geometrical entities. But the treatment of complex geometrical elements is unsatisfactory in most English text-books, and the author of this one follows many precedents in the course he has adopted.

We cordially recommend Prof. Sommerville's book both as a work of reference for mature readers and as a text-book for students desiring to make a serious study of analytical conics. The numerous problems will be specially valuable to the latter. W. E. H. B.

Cancer: How it is Caused, How it can be Prevented. By J. Ellis Barker. Pp. 432. (London: John Murray, 1924.) 7*s.* 6*d.* net.

WE cannot agree with Sir W. Arbuthnot Lane that this book "will prove a great boon to mankind" or "that it is easily the most important practical work on cancer existing in English or in any other language." These statements are extravagant or, at least, very doubtful. Mr. Barker's book is the work of a journalist and is from beginning to end uncritical in a scientific sense. He states (p. 110) that he is "fully acquainted with the latest discoveries," but if so he has not given them to us but has used his book to express his opinions that cancer is due to constipation and lack of vitamins, two views which in our opinion have little foundation in fact. Almost the only authorities he quotes are surgeons—notoriously the least fertile of our medical researchers—whom he describes by some appropriate adjective such as great, very great, able, eminent, famous, or celebrated. Their statements, mostly from the general press, are regarded by Mr. Barker as an authoritative canon. We are reminded with irritative frequency that Sir W. Arbuthnot Lane has said, "Cancer never affects a healthy organ or healthy tissue." Sir W. Arbuthnot Lane may believe this, but it is our duty to point out that there exists a very extensive scientific literature for and against this opinion.

The whole aim of Mr. Barker's book is to put forward the pious belief—it is nothing more—that cancer is a disease of civilisation and is associated with constipation, which can be alleviated by eating raw food a roots like the beasts in the field. A great deal is m of the catchword "auto-intoxication." If Mr. Bar would like to know how little is the knowledge wh science possesses on intestinal auto-intoxication can commend to him the article by Dr. W. C. Alva in *Physiological Reviews* (1924, vol. iv. pp. 352-393)

In our opinion the book will do much more ha than good, as it can only have a deleterious action a make people concern themselves with morbid sympto in their abdomens. It may lead to a few intesti "kinks" being unkinked, but it is very improba that Mr. Barker's precepts will have any influence the incidence of cancer of the abdomen or elsewhere

Evolution at the Crossways. By H. Reinheimer. 191. (London: The C. W. Daniel Co., 1924.) 6*s.*

TWENTY-FIVE years of dietetic experiment have enal the author to frame new theories of evolution. Lik disciple of M. Coué, he states that to be true wh he wishes to be true, and produces a picture of world which will be pleasant to many.

"Selectionists . . . impute a very low kind morality to Nature—low enough to approximate ruthlessness of elemental forces"; but for Mr. R heimer "the roots of morality go back to the mut relations existing between the lowliest of organis the nitrifying bacteria." "Palæontology shows t those organisms which have aimed at a self-suffici life, have received no encouragement from Natu "Parasites are failing species." "An organism, order to persist on the road of progress, must seek provender amongst the spare products of anot kingdom." "Habitual predacity invariably leads protoplasmic impoverishment." For "the frugivor animals, including man himself . . . their high p rogative was purchased by biologically righte behaviour." "A carnivorous career necessitates inordinate supply of blood to the large fangs, whic the cause of the brain being fatally under-supplie (The relative brain-power of dogs and sheep is discussed.) Righteous birds feed on grain and fr and righteous insects on leaves. (The debt of a culture to unrighteousness is not discussed.)

Many will admire this book, whom we cannot rem that sharks are older than land-animals, and carnivor echinoderms older than sharks; that most animals in the sea, and of them nearly all larger than a r grain are carnivorous; that beautiful fish are not predaceous than ugly fish; and that the product of thousands of eggs for one to survive is not "a fo of disease and penalisation," but is repetition of ancient marine habit still followed by most fem animals, and by all males. G. P. B

Animal Life in the Yosemite: an Account of the Ma mals, Birds, Reptiles, and Amphibians in a Cr section of the Sierra Nevada. By J. Grinnell a T. I. Storer. Pp. xviii + 752 + 62 plates. (Berkel Cal.: University of California Press, 1924.) 7 dollars.

THE present volume describes a survey of the ve brate natural history of the United States Natio Park of the Yosemite region, the geology and bot of which had previously been explored. It was und

ken by the California Museum of Vertebrate Zoology, object being to learn the species and the local distribution of each, to map out the general life areas, learn the food relations and breeding habits of the species, and, finally, to present all in a form accessible the public, both lay and scientific. The section studied is divided into six zones, the characters of which are enumerated, the species found in each being shown pictorially; as the Sierra crest is 10,000 to 1,000 feet in altitude and the two sides of the divide differ greatly in aridity, there is clearly plenty of scope. Censuses of birds observed are recorded, numbers of each species seen in stated times and distances in each zone. The balance of Nature from insect to bird, bird to tree, and tree to insect is claimed to be mutually beneficial. Then follows a typical natural history account of each of the 246 species of mammals, birds, reptiles, and amphibians that were found, the book closing with an excellent bibliography and more than sixty well-chosen plates illustrative of the fauna. We should certainly have this book with us if we were visiting the Yosemite region, for, as a first complete work on the locality, it adequately fulfils its object. It will be a useful basal foundation for subsequent periodical surveys to ascertain the changes taking place in the Park due to the closer settling of neighbouring regions.

The Marine Plankton, with special reference to Investigations made at Port Erin, Isle of Man, during 1907–1914: a Handbook for Students and Amateur Workers. By Dr. James Johnstone, Andrew Scott, and Herbert C. Chadwick. Pp. xvi+194 (20 plates). (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1924.) 12*s.* 6*d.* net.

This is an account of the researches of the authors on the distribution and succession of the plankton in a particular area of the sea. Apart from the important data recorded here, the book gives an admirable account of how a research of this kind is and should be conducted. It can therefore be used as a preliminary guide by any one who wishes to pursue a similar research in other parts of the sea.

After an opening chapter on "The Plankton in General," a large series of illustrations is given of various plankton types. These enable the student to identify the main classes to which the organisms of a particular plankton sample belong. A chapter on the distribution in space of plankton and the succession of forms throughout the year then follows: this is based on the authors' researches. The last chapter gives an account of nutrition in the plankton and of organic production by plant and animal organisms.

There is a valuable appendix on methods to be employed, and a short bibliography from which further references can be obtained. The illustrations are very good. The reference to the quantum theory on p. 156 is perhaps rather out of place in a book of this scope; the account is necessarily too short to be clear, and does not really seem to be of importance to the argument.

This kind of book is unfortunately not common enough. One cannot help wishing that there were books of a similar scope and price to help the student of, for example, fresh-water biology.

The Principles and Practice of Fly and Bait Casting. By Reginald D. Hughes. Pp. xi+80+8 plates. (London: A. and C. Black, Ltd., 1924.) 5*s.* net.

Mr. Hughes is both a caster and an angler, that is, he is an expert in the art of casting for its own sake, without regard to its application to the sport of fishing, and also an enthusiastic angler, who has brought to the pursuit of his sport all the knowledge acquired in the practice of his art. His book, therefore, will be of the greatest service to anglers. It covers both branches of angling, dry-fly fishing, and fishing with bait, and in each case the general principles involved are discussed, and precise and careful directions given for both single-handed and double-handed rods. The veriest tyro can follow the author's instructions with ease, and should, by careful attention to detail and assiduous practice, acquire that precision in casting which will add to the pleasure of his sport and to the weight of his basket. Clear illustrations and drawings help the text very materially, and anglers will be grateful for the sound advice so clearly and concisely given. Casting is not fishing, as the author is aware, but that correct casting is the first requisite in the making of a successful angler, no one, least of all anglers themselves, will deny.

A Dictionary of Electrical Terms: for Electrical Engineers and Students. By S. R. Roget. Pp. vii+296. (London: Sir Isaac Pitman and Sons, Ltd., 1924.) 7*s.* 6*d.* net.

As many new branches of applied electricity are continually developing, new terms come into use, and it is difficult even for the professional electrician to remember what they all mean. This book of Mr. Roget's therefore fulfils a useful function. For example, it is no use to look up in an ordinary dictionary to find out what a traction engineer means by an "ear" or a "frog," or an illuminating engineer means by a "lux" or a "lumen." We are glad that the author includes American terms. Every electrician must now read a certain amount of American technical literature, and he might easily be puzzled by such terms as "resistor," "inductor," "quarter-phase," etc. We can congratulate the author on having got such a comprehensive list into such a small volume. It will prove useful to many.

The Racing Eight: Notes on its Design and Propulsion. By W. B. Coventry. Pp. iv+39. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1922.) 3*s.* 6*d.* net.

Mr. Coventry's aim is to discuss how to obtain the maximum speed out of a racing eight. It is clear that the design of the boat is an important factor determining the success or failure of the crew, and the author claims that in several cases the result of the Universities Boat Race was due to the superior design of the boat used by the victors. His chief contention is that a racing eight should be as short as possible. He bases his view on theoretical grounds, as well as on the successes achieved by the short boats constructed by Mat Taylor of Newcastle for Oxford in 1857 and for the Chester Rowing Club in 1856. In his theoretical investigation he assumes that the resistance is mainly due to surface friction on the wetted surface, being proportional to the wetted area and to the 1·852 power of the speed. S. B.

Letters to the Editor.

(The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

A New Method of Investigating Sea Waves.

THE common methods of investigation of a high sea permit the height and the length of waves to be measured, but do not give any means of determining the changes of form of the wave, which can sometimes differ considerably from the simple form of a trochoid. "Forced waves" especially undergo deformation inasmuch as their steepness has often to be left out of account. Precise stereo-photogrammetric methods are always complicated, cumbersome and slow, which reduces their applicability to large amounts of material, as in other regions of geophysics. In such cases, when comparisons of the steepness of waves have to be made with large masses (as in the comparison of ocean and smaller sea waves) in order to study the relations between it and the wind-velocity, etc., the following method can be used.

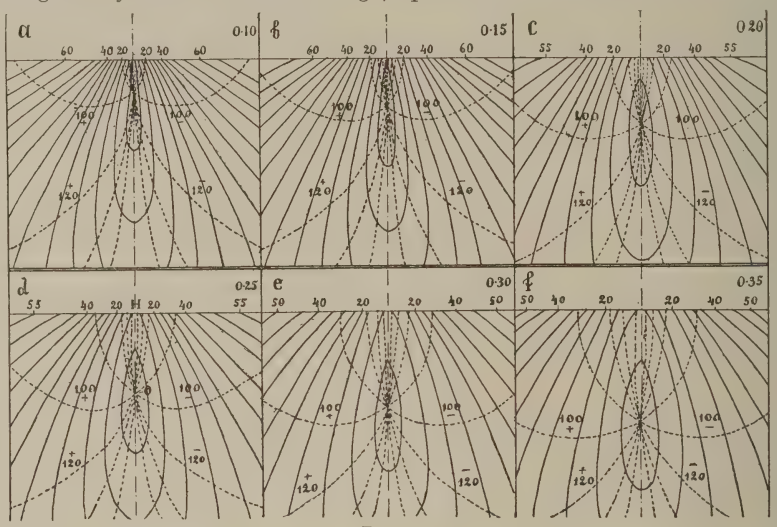

FIG. 1.

If rays from the sun fall upon a perfectly ca mirror-surface of water, an observer sees a sin reflected image of the disc of the sun (or the m may be used) at a point which makes with horizon the same angle downwards as the heave body is above the horizon. In reality, there generally instead of a single image a series of s shining spots, forming a shimmering strip upon waves through reflection of the luminary in numerable mirrors from differently inclined eleme of the sea waves. By following the rays of lig one can find the relation between the position o sparkle on the surface of the sea and the inclinati of the correspon ing element of t wave, as well the direction of path. To cre a clear picture a high sea it best to use a n of isoclinals curves of an equ inclination waves to the ho zontal plane) a isogonals (sho ing an equal rot tion of a wav element about t vertical axis) projected on t surface of the s in the place of t strip of glitteri spots under t sun (or moon). such a net, co structed by me by means of a very simple instr ment [1] for six different heights of the sun (Fig.

FIG. 2.

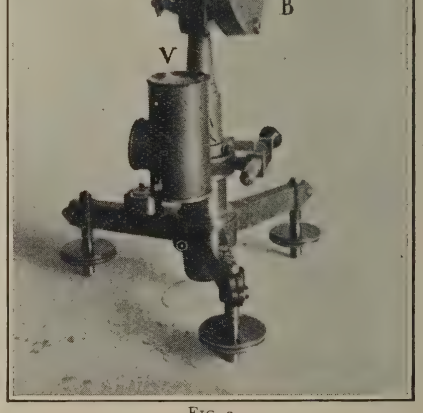

FIG. 3.

may be superposed a photographic negative of th light strip on the sea surface.

[1] Was. Shoulejkin, *Nautical Magazine*, 1924, and Hydrographic Memoirs of Russian Hydrographic Office, 1924.

The scale of nets (Fig. 1) may be such that the distance *HO* (Fig. 1, *d*) is equal to a quarter of the focal length of the apparatus used in taking the photographs. As an example, I give here a photo (Fig. 2) superposed on a net. As will be seen, the predominating steepness of the waves is here equal to 15°. The steepness of small waves arising from the surface of the chief waves is nearly 35°. A gush of wind is evidently creating capillary waves with an azimuth +120°, as can be seen from the sparkles superposed upon corresponding curves.

If observations are made, not from a ship, but from the sea shore, photographs are unnecessary; it is sufficient to project a corresponding net of curves (Fig. 1) directly on the sea surface. For such observations I have constructed an instrument, illustrated in Fig. 3. In the field of the eye-piece, *O*, of the tube *OS* is placed a revolving disc (enclosed in the round box *B*) with six sets like those of Fig. 1. The observer rotates the instrument about the vertical axis until the image of the sun's (or moon's) disc appears on the control-line of the ground-glass (*V*). On this control-line are marked six points, corresponding to six particular heights of sun, and provided with the same numbers as the sets of the revolving disc. After noticing at which of the points the sun's image is situated, the observer brings into the field of view the net with the corresponding number, and he can then easily find the steepness of the waves as well as their direction.

It would be of interest to make observations of the influence of wind-velocity, and of the depth and size of the basin, on the steepness of the waves, possibly on a large scale, by means of this simple method.

WAS. SHOULEJKIN.

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The "Ship-designs" on Prehistoric Egyptian Vases.

THE interpretation of the ship-like designs painted on the light-brown vases of prehistoric Egypt, such as those figured by Sir Flinders Petrie on plates xix.-xxii. of his "Prehistoric Egypt," has given rise to considerable discussion. These designs, which have been considered to be "stockaded forts," "barbaric designs of boats," or "sea-going galleys," present a more or less curved structure from which a long series of tall columns or "fringe-like lines" (Budge) depend from its under margin at about equal distances apart. Those who adopt the boat interpretation consider these fringe-like lines or columns to be oars. Others interpret them as sand-ripples. Upon this curved structure stand two erections designated "cabins" by some writers; by others as "two blockhouses forming a pylon entrance." They stand on each side over above a gap in the pendent series of fringe-like lines. The majority opinion supports the view that these pictures are ship-designs; but many find it difficult to convince themselves of the reality of this interpretation for several reasons.

The body of the structure, or platform, is certainly boat-like and is probably modelled upon a boat; but the pendent columns, which obviously have no resemblance to oars, all originate from the lower margin of the platform and are never shown reaching as high as the gunnel level, which they would naturally do if they were oars; nor in any of the designs are there ever any indications of rowers. The number of the pendent fringe-like lines, which varies from 30 to 70 on a side, is out of all proportion to that required as oars, even if the structures represent sea-going galleys. Moreover, 60 to 140 sailors could not be accommodated, not to speak of their oaring, in the space provided for them on any of the crafts pictured. Sir Wallis Budge, while accepting the adscription of these structures to boats, considers the "fringes cannot represent oars," but "the water through which the boat is passing." If the fringes be not oars, it seems to me that the rest of the picture can scarcely represent a boat. The identification of the fringes with water, however, fails to explain the invariable behaviour of this element in spacing itself opposite the cabins on the deck; or why in Vase Brit. Mus. 32,639 the usual hieroglyphic for water, employed in the upper part of the panel, is so different from the "water" of the fringe-like lines.

Since the pottery decorators of the period knew quite well how to delineate "with unusual delicacy and spirit" boats with boatmen in action, and in appropriate number, as plate xxi. 46K of "Prehistoric Egypt" attests, it is difficult to understand why artists so capable should draw such barbaric objects if they intended them to be boats. These pendent columns (*tom. cit.* plate xix. 40M) are frequently represented, by the usual hieroglyphic, as set in water. Although this sign is often omitted it may be taken for granted, since all these ship-designs are so similar, that they all bear the same relation to water, associated as they are so frequently with a long-legged wading bird—the flamingo. I suggest that the associated flocks of flamingoes supply the key to an interpretation of the designs in question somewhat different, I believe, from any so far proposed. It is important to note that the birds are flamingoes and not ostriches. "The Cambridge Ancient History" (i. p. 570) and Sir Wallis Budge (Brit. Mus. Guide to the IV. etc., Egyptian Room, p. 247) designate these birds ostriches.

In 1909 I suggested in NATURE, with regard to the same scenes, that the birds were flamingoes, not ostriches, a view which has been accepted by Sir Flinders Petrie and others. The scenes under discussion are much too watery for birds with feet adapted to the hot desert sand. The pictures are consequently not river scenes, which flamingoes do not frequent, but shallow lagoons, or inundated marsh lands beloved of these birds, which are here seen at home, and not passers-by on the wing, or casually resting. In such lagoons surely (since the water does not reach half up the flamingoes' tarsus) it would be impossible to navigate a craft requiring 140, or even 70 oarsmen. The figured structures therefore, I suggest, are not craft either for river or sea navigation, but represent in front view, perspective disregarded, watchers' naviform pile-platforms or hunting-lodges supported on reed piles set up in the delta lakes or the marshes—hunting-grounds from time immemorial. On plate xix. 41U (*tom. cit.*) there are seen the halves of two mounds of concentric wavy circles, which might excellently, and probably are meant to, represent, in plan, flamingoes' nests, which, as is known, are composed of mud built up in zones of decreasing diameter to a summit depression a couple of feet out of the water.

The ruminants pictured in the same scenes, and in some of them apparently inside the "lodge," probably represent animals—including a flamingo—either captured and imprisoned for domestication, or subjects for capture still feeding in the fens. The flowering plants so often figured in relation to these ship-designs seem to me (if I may dare to differ from a botanist so well versed in the African flora as Prof. Schweinfurth) scarcely to represent the aloe, a plant with which I was familiar in Sokotra, where, as in Egypt, it was hung as a charm over the doors of houses. Only one flower stalk arose from each root-stock; in these scenes there are sometimes more than one. Besides, the habitat of the aloe is in dry, rocky or sandy situations; a flamingo-frequented

marsh would not suit it. The figured vegetation recalls to me rather foreshortened date-palms with branching fruiting stems, showing in addition the cabbage—prized as a vegetable—in the crown of the palm. Sir Flinders Petrie, however, is of opinion that they are "aloes in tubs or vessels around which the leaves hang," as they are "never represented as springing from the ground." If so, the tubs must be standing in the watery mud. The stem of the plant (Petrie's "tub" I take it) shows palm-like growth-rings; and though it does not reach the water or ground, neither do always the "oars," the birds' or the ruminants' feet. The fan-like objects (*tom. cit.* plate xx. 44D) among which the flamingoes are wading, appear to me to represent young palms growing from the nut (which in palms sprouts without necessarily being covered) in or on the edge of the water, as I have seen them throwing up a single leaf on the marshy edge of the river of Hadibu in Sokotra.

The two erections midships on the deck (resembling cabins on paintings of unmistakable boats), each flying its Nome ensign, may be entrance gateways, or perhaps shelters. The gangway between them is invariably situated over the gap in the piles, the discontinuity of which would facilitate landing at the lodge from a reed-bundle float or small boat, or afford a passage-way underneath the lodge. The overhanging branch at one end may serve for shade—perhaps branches with dates for refreshment—just as it does at the look-out end of navigable Nile boats; while the tying-up rope dangles from the stem for the purpose of mooring any visiting boats.

HENRY O. FORBES.

"Deanway,"
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The Supposed Constancy of the Hybrid between the Common and the Water Avens, *Geum urbanum* × *rivale*.

IN several publications issued during the last few years,[1] M. L. Blaringhem has asserted that the hybrid *Geum urbanum* × *rivale*, sometimes described as *Geum intermedium*, retains its character unaltered during subsequent generations, and he cites this plant therefore as an example of the constancy of an interspecific hybrid. In making this assertion M. Blaringhem neglects to take account of the result of experiments carried out by us,[2, 3] which are in direct contradiction to the view he puts forward. We should like therefore to direct attention to the facts observed by us and confirmed by further experiments.

Our observations were made quite independently, and have resulted in the establishment of the fact that a distinct segregation of characters takes place in the f_2 generation of this hybrid. This segregation concerns a considerable number of characters.

1. The *inclination of the peduncle* varies both towards the pendant condition of *G. rivale* and equally towards the erect position of *G. urbanum*.

2. The *presence of anthocyanin* in the peduncle and calyx, which the f_1 generation inherits from the Water Avens, varies considerably in degree in the f_2 generation, and this colouring matter may be almost absent in some specimens.

3. The *calyx*, which is more or less expanded in the f_1 generation, shows this condition in the majority of cases in the f_2 generation, but some individuals possess the closer calyx of *G. rivale* and others the reflexed calyx of *G. urbanum*.

4. The *colour of the flower* in the f_1 generation partakes of the character of both parents, the petals being yellow on their inner and red on their outer surfaces. In the f_2 generation there is a distinct segregation of yellow colour, about 75 per cent. having this colour and 25 per cent. lacking it, according to observations of one of us. This proportion agrees with the Mendelian ratio 3 : 1. The red colour varies considerably in degree in f_2, but scarcely any individual is found to lack this colour entirely. This may be explicable by supposing this colour to be due to several factors.

5. A segregation is also presented by the *form of the petals*. Thus, one of us has shown that in the f_2 generation 49 individuals had notched while 159 had entire petals, figures which approximate very closely to the Mendelian ratio of 1 : 3.

6. The *stipules* were observed to show considerable variation in size in the f_2 generation, tending towards those of the respective parents.

It seems curious that, in spite of such obvious segregation to which we have directed attention, M. Blaringhem should still maintain the former his erroneous view that *Geum urbanum* × *rivale* is an example of the constancy of hybrids between different species. This is all the more remarkable as M. Blaringhem admits in his publication of 1922 the occurrence of some variation in this hybrid. We can only imagine that he has not recognised that such variation is due to segregation because some of the characters may be due to two or more factors; so that to obtain completely recessive forms it is necessary to cultivate a very large number of individuals.

As M. Blaringhem's erroneous view of the constancy of hybrid *Geum urbanum* × *rivale* may gain currency among those who are not familiar with the progeny of this plant, it seems desirable to direct attention to the results of the experiments carried out by us prior to the publication of his conclusions.

F. E. WEISS.
D. ROSÉN.

The Victoria University of Manchester.

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[2] Rosén, D. Kreuzungsversuche G. urbanum L. × rivale L. *Botaniska Notiser*, 1916.

[3] Weiss, F. E. Geum intermedium (Ehr) and its segregates. Report Brit. Ass., Dundee, 1912.

Fine Structure of X-Ray Absorption Edges.

IN the issue of the *Zeitschrift für Physik* for July 1924, Dr. Coster reports the existence of a white line on the long wave-length side of the absorption edge in the case of the higher valence forms of various elements. Evidence has been obtained in the laboratory that iodic acid and potassium permanganate, two of the substances for which he reports this line, are slowly reduced by X-rays. If this occurs in the absorbing screen, it seems reasonable to expect that the photographic plates will show not only the absorption edge of the original compound, but also that of the reduced portion. According to Lindh's results with phosphorus, sulphur, and chlorine, the absorption edge of the reduced form might be expected to fall on the long wave-length side of the main edge. It seems reasonable, therefore, to raise the question whether the white line Dr. Coster reports may not be the absorption edge of that part of the material in the absorbing screen reduced by the X-ray.

In the effort to discover whether reduction of iodic acid could be demonstrated chemically, we have sealed portions of a 25 per cent. solution of iodic acid in water in thin walled glass test-tubes, with suitable precautions to prevent reduction by the heat of the blast lamp. In one of these tubes of iodic acid

ced a cubic centimetre of chloroform and in ther an equal amount of carbon tetrachloride, both which give a pink coloration in the presence of iodine. The other tubes contained only iodic and were broken open and tested with chloroform after X-raying for a number of hours. All the es gave the test for traces of iodine after exposure the X-rays. Solid iodic acid crystals take on a wnish coloration when X-rayed, but it has not been found possible to demonstrate conclusively at this coloration is due to free iodine. A very ute solution in water of potassium permanganate s found to have lost its pink colour and to have come distinctly yellow after being exposed to rays for an hour, thus indicating reduction of the rmanganate ion.

A little evidence has also been obtained on the ectrographic side. We have taken plates of the ilic acid L_3 absorption edge with a Siegbahn ectrograph, using two different absorbing screens, e containing iodic acid free from all traces of iodine the chloroform test and the other containing iodic id contaminated with traces of iodine or iodide. he white line on the long wave-length side of the ge was more pronounced with the impure iodic acid.

The spectrographic data available would also seem support our hypothesis in that it shows a rather markable agreement between Dr. Coster's values for e white lines with highly oxidised compounds and e values for the absorption edges with the free ements. In the case of iodic acid, he gives 11·5 X units for the white line and 2712 for the sorption edge of free iodine. For tellurous acid, reports the white line at 2846·9 X units and his alue for the edge of metallic tellurium is at 2847·1. e have just obtained the absorption edges for etallic antimony and metallic tin, and the agreement ith the white lines Dr. Coster reports for the idised compounds of these elements is equally riking. He reports white lines at 2991·1 and at 147·5 for the oxidised compounds, and we have und the absorption edges for the free elements at 991·5 and 3146·9 respectively. Thus, in the case of l four elements, the absorption edge for the free ement is within a fraction of an X unit of the value r. Coster gives for the white line. This, coupled ith the fact that X-rays can act as a reducing gent, would seem to be definite evidence in favour f the hypothesis that a part of the highly oxidised mpound in the absorbing screen is reduced and at the white line reported is the absorption edge of e reduced portion. KATHERINE CHAMBERLAIN.

Physical Laboratory,
University of Michigan,
August 31.

Low-Voltage Arc Spectra of Copper and Silver.

IN NATURE of July 21, 1923 (vol. 112, p. 100), was ublished a letter from me giving results I had obained on the ionisation potentials of copper and silver apour by the low-voltage arc method. The spectroopic examination of these metals is complicated y the fact that the spectrum of the ordinary arc ontains large numbers of spark lines. By using a hree-electrode arrangement *in vacuo* such as was sed by Foote and Mohler, I have succeeded after ome difficulty in obtaining spectrograms of the ltra-violet arc spectrum of silver vapour entirely ree of spark lines. The only lines appearing are the irst two pairs of the principal series. The wavengths of the second pair, as measured by Pina, are ot correct. The small quartz spectrograph which as used in these experiments, and was in perfect focus, gave values always within 0·1 Å of the calculated wave-lengths quoted by Fowler. This is sufficient evidence that the value of the ionisation potential given in my former letter is incorrect.

The arc spectrum of copper is, of course, complicated by the presence of at least one "X" level between $1S$ and $1\pi_1$, which makes it possible for arc lines other than principal series lines to appear below the limit of the subordinate series at about 3145 Å. The arc in vapour at 8 volts gives a large number of lines terminating with a single line. This line I have measured on five plates of the ordinary arc, and have obtained values 2024·30 Å, ·35, ·30, ·34, ·36, giving an average of 2024·33, the value calculated for $1S - 2\pi_1$. This line is very strong in the low-voltage arc and it certainly cannot have any accompanying line of comparable intensity at 2025·67, the wave-length calculated for $1S - 2\pi_2$. This throws much doubt on the accepted interpretation of the X-combinations leading to these values.

The three-electrode apparatus which gave only arc lines in silver shows the copper lines given in List I., when operated at 8·2 volts and 6 m.a. These lines are almost certainly arc lines, and must, therefore, be combinations either with $1S$ or with terms of type X. They should be important in the disentanglement of the copper arc spectrum.

List I.

2165·08	2824·42
2179·39	2883·00
2181·74	2961·19
2225·68	3010·90
2230·11	3036·09
2441·67	3063·41
2492·15	3247·55
2618·39	3273·96
2766·38	

List II. contains lines extra to List I. which appear on a plate taken with an 8-volt arc in copper vapour. These lines must be either arc lines or easily excited spark lines. The wave-lengths are those given by Huppers. All the lines are so faint that intensities cannot very well be given, but the very faint lines are indicated with an f.

List II.

2024·33 (calc.)	2238·46 f
2138·54 f	2244·22 f
2199·64	2260·48
2214·58	2263·07 f
2215·68	2293·85
2227·74	2392·64
2236·28 f	2997·38 f

The difficulty of obtaining spectrograms of the visible region is much greater because of the high temperature of the filament and furnace, and so far only one rather unsatisfactory photograph has been obtained. It is hoped, however, to cover this region in the near future. A. G. SHENSTONE.

University of Toronto,
August 18.

Organisation in Chemical Societies.

IN common with all other members of the Chemical Society, I have received a notice to the effect that there is to be a virtual increase in the annual subscription, in that an extra charge will be made for the Annual Reports, which have hitherto been supplied to members free of charge, and at the same time directing attention to the need for increasing the membership of the Society. I have little doubt that the result will be that many members of the Society will not purchase the Report; but as this publication appeals particularly to students, and as it is from men

of this class that the Society should draw its new members, I fear that the new policy will defeat its own object.

I take this opportunity of directing attention to the position in which the lack of organisation in the chemical world places the younger men, and in particular those who are entering industrial life. The young industrial chemist may be expected to belong to the following organisations, and to pay the corresponding subscriptions, in addition to entrance fees, which I have not set down :

The Chemical Society . . .	3*l.*	0	0
Institution of Chemical Engineers .	5*l.*	5	0
Institute of Chemistry . . .	2*l.*	0	0
Society of Chemical Industry . .	2*l.*	10	0
Faraday Society	2*l.*	0	0

The total amounts to an annual charge of nearly fifteen pounds, and in addition there will be the subscriptions to be paid to one or more specialised organisations.

Between them these societies do not possess a library which is in any way comparable with the Patent Office Library, or a lecture hall which will accommodate even a moderately well attended meeting ; no set of *abstracts* comparable with "Chemical Abstracts" of the American Chemical Society is published in the country. These are hard things to say, but it is time that attention was directed to the facts.

A recent attempt of my own to recruit for one of our societies met with failure, as my intended victim pointed out that "he had the use of the Patent Office Library free, and generally preferred to attack his chemical literature through the publications of the American Chemical Society." Will any chemist suggest a suitable reply ? I have not been able to think of one.

When reorganisation of the societies connected with chemistry is suggested, it is always stated that it is impossible to raise the money which will be required. I have had a good deal to do with the raising of money for such objects, and there is one thing I know in connexion with the matter. It is this. If you want to raise money you must show that you are spending what you have got economically. You must also show that you know what you want, and what you are going to do with the money when you get it. If, as is rumoured, schemes for reorganisation are under consideration, it is well that they should see the light of day in a form in which they can easily be understood, and as soon as possible.

M. W. TRAVERS.

147 Queen Victoria Street,
London, E.C.4,
September 22.

Surface Tension and Fine Particles.

THE formation of colloidal particles is undoubtedly influenced greatly by the forces of surface tension, which will tend to cause the coalescence of fine crystals into small amorphous bundles probably spherical in shape. An elementary investigation into the forces at work shows that the activity due to surface tension effects, when one is dealing with very small particles, may be very much more pronounced than is the case with our usual observation of larger masses.

If we consider the case of two equal small spheres of matter brought together, for example, two small drops of water in air or two colloidal particles in a liquid, surface tension forces tend to make them coalesce into one body having the least possible area. The action is regulated by the law that the reduction in the potential energy of the surface is equal $T \times \Delta A$, where T is the surface tension between surface of the particles and the surrounding medi (supposed constant) and ΔA is the change in a due to coalescence. The total change in energy then proportional to the square of the radius of particles (r). This change of energy is the seat the force pulling the particles together and deform them into a new shape. As energy has the dimensi of FL, we have a quantity of dimensions (FL) vary as r^2, and consequently the force involved will va as r. Now force induces in mass an acceleration, a consequently the acceleration (a) produced by surface tension action is such that $a \propto F/m$. Si $F \propto r$, and $m \propto r^3$, the acceleration produced var inversely as the square of the radius of the particle

Although, of course, no definite acceleration c be determined in any particular case, the above sho that what we might call the "activity" of the eff of surface tension on small particles will vary inversa as the square of the radius of the particles and, very small ultramicroscopic particles, the rapid of this action will be far beyond anything that we acquainted with in ordinary macroscopic observati

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The "Hole, Slot and Plane" Geometrical Constraint.

A DETAIL in the "hole, slot and plane" geometri constraint (which is one of the commonest forms the "six point support" mentioned in Sir Geo Greenhill's letter in NATURE of September seems often to be described and constructed wrong. In this constraint, one contact occurs between rounded projection on one body and an approximat "plane" part of the second body ; two conta occur between a rounded projection and the si of a groove or "slot" ; and the remaining *th* contacts should therefore be arranged to occur the "hole."

The "hole" contact should not consist of a coni point resting in a conical hole of larger angle ; contact would not occur at three places, and the t cones cannot be made accurately right to their apic If a conical projection be used, resting in the end a simple circular cylindrical hole, contact would general occur at two places. If the axes of the co and cylinder were coincident (or if a sphere w used in place of the cone), line contact would th retically occur, the actual places of contact dependi in practice on the accuracy with which the surfa were shaped. The *three* contacts at the "hol could, however, be made by using a spherical conical projection resting in the end of a hole triangular transverse section (or resting on th spheres or three cylinders attached to the seco body).

W. N. BOND.

University College, Reading,
September 17.

The Large Black Slug at Honolulu.

LAST month, when in the Mansa Valley, Honolu Hawaiian Islands, I became acquainted with the lar slug which is now common in that locality. A livi specimen was handed to me by Dr. Robert Faus, a later Dr. Montague Cooke gave me a good series fr the collection of the Bishop Museum. Until rece years these slugs were unknown in the islands, and

doubt remained that they had been introduced. Nevertheless, as Dr. Cooke informed me, no one knew whence they came, or what (if any) described species they represented. I find that they agree with *Veronicella levdigi*, described from specimens collected at Brisbane, Queensland. Simroth, who made the species known, gave good coloured figures, and figured the anatomy. Henry Tryon (1899) gave a popular account of the slug, showing that it was destructive in gardens. Both he and C. Hedley were of the opinion that the animal had been introduced from some unknown locality. Dr. Willey found specimens at Vasafate, New Hebrides, and this may be the original home.

The species will be known by its large size, dark colour above, with a slender yellowish line; more or less black beneath (as well shown in Simroth's figure), with pale sole. I described the living specimen thus: Upper tentacles black above, dull yellowish below; lower tentacles stout, pale basally, black at apex; back dull black, with a slender broken pale ochre-tinted line, best defined posteriorly; underside black, with the sole dull pale yellowish; length about 80 mm., width about 25 mm., width of sole about 13 mm. Internally, a noticeable feature is the great length of the filiform glands. Probably this slug has been carried to other places, and it will be of interest to record new localities, should they be found. The specimens described by Simroth were not of full size, but the large size of well-grown examples is shown by Tryon, who gives a good photographic plate.

T. D. A. COCKERELL.

University of Colorado, Boulder,
September 3.

The Preparation of Line Sources of Radium C.

WHEN an active line source of radium C is required, the usual method of preparation is to seal a platinum wire into the end of a glass tube. Radium emanation is pumped into the tube with mercury, the wire being made the negative electrode with the mercury just beneath the wire forming the positive electrode. After a sufficient exposure, the emanation is pumped off, and the glass tube broken to remove the source. Even with quantities of emanation so small as 10 to 20 millicuries, the efficiency is very low, only 10 to 15 per cent. of the active deposit being found on the wire. This low efficiency is probably due to the distribution of the potential gradient along the wire. The drop takes place between the end of the wire and the mercury, while in the upper part of the tube there is practically no potential gradient. Thus most of the emanation is in a "dead" space.

The efficiency may be increased fourfold by the following device, which has been in use here for some time with satisfactory results. The wire is sealed into the tube as before, and a thin foil of iron or nickel, which will not contaminate the mercury, is slipped into the tube, forming a cylindrical sheath around the wire. The emanation is pumped into the tube and the mercury level raised until it makes contact with the sheath. The wire is made negative and the mercury and sheath positive. 110 volts gave 40 to 45 per cent. of the active deposit on a wire of 0·4 mm. diameter; 200 volts gave an efficiency of more than 50 per cent. The tube should be of not less than about 7 mm. internal diameter, and the foil should fit as snugly as possible against the wall right up to the end of the tube.

G. H. HENDERSON.

University of Saskatchewan,
Saskatoon, Saskatchewan.

Recent Work at Stonehenge.

THE extremely interesting article of Col. Hawley in NATURE of September 20 leads me to ask him two questions which are raised by it:

(1) Were the Bronze Age interments found on both sides of the rampart, or only on the outer side?

(2) Are the "Aubrey Stones" contemporaneous with the main structure of Stonehenge, or were they a subsequent addition?

A description of Stonehenge has long been recognised in Diodorus Siculus (ii. 47), which he derived from Hecatæus, a writer of the 6th century B.C., "& some other" authors. We are told that it was dedicated to Apollo, the sun-god, in whose honour a great festival was held every 19 years which lasted from the summer solstice "to the rising of the Pleiads." We are further told that in the immediate neighbourhood was a city inhabited by the priests and their disciples, who worshipped the god daily with hymns and the harp. It would seem to follow that in the time of Hecatæus or his authorities the sacred precincts of the temple could not as yet have been desecrated by cremation burials.

A. H. SAYCE.

8 Chalmers Crescent, Edinburgh,
September 23.

THE Bronze Age interments referred to by Prof. Sayce occurred both on the inside and outside of the Stonehenge rampart, but by far the greater number were on the inside and at the bottom of the slope. Here there is loose soil about 14 inches deep of humus and chalk rubble, affording easy digging, in which the remains had been deposited without any attempt to make a cist to contain them.

Occurrences of interments on the outside of the rampart were six in number, but the remains were deposited with greater care. They were found at the top of the silt which had filled the ditch, and were placed in bowl-shaped cavities excavated to about two feet from the surface where the rampart slope joins the silt. Owing to deeper burial, they were better preserved and were coated with a thicker deposit of lime than those found inside: they were also greater in quantity and probably represented the remains of an entire body, whereas those on the inner slope were mostly only portions of cremations.

The Aubrey Holes were evidently of Pre-Stonehenge date, as the stratum of that period passed over them and the chips characteristic of it were not found in the soil filling the holes. They were evidently open holes during the neolithic period, for in one of them there was a quantity of chips which had been discarded by an implement maker and evidently struck from one large piece of flint. Some of them can be fitted together, and when so placed it is interesting to see where the blow was delivered to detach them. There is a description with drawings of twenty-three of these holes in a report to the Society of Antiquaries given in the *Antiquaries' Journal*, vol. 1, Part 1, of January 1921.

I have read the supposed description of Stonehenge given by Hecatæus of Miletus, but regard the existence of a city anywhere near here to be impossible. There are no Bronze Age settlements very close, and those with which I am acquainted in the neighbourhood must have been extremely primitive and rough: very dirty too, if one may judge by the refuse of black ashes, animal bones, and sheards of badly baked pottery strewn about them.

WILLIAM HAWLEY.

Asiatic Expeditions of the American Museum of Natural History.

By Dr. HENRY FAIRFIELD OSBORN.

THE Third Asiatic Expedition was projected in the year 1920 as a sequel to American Museum explorations in Japan, Korea, China, and Mongolia, collectively known as the First and Second Asiatic Expeditions. The first and second expeditions were purely zoological in purpose; the third was planned to occupy the very much wider field of geology, palæontology, botany, zoology, and anthropology. The leader of these expeditions, Roy Chapman Andrews, crossed Mongolia during the season of 1919 and observed that the broad level stretches of the Gobi Desert, bordered with gentle terraces, lent themselves to exploration by automobile as well as by the older method of camel transportation, and he conceived the plan of a geological and palæontological expedition

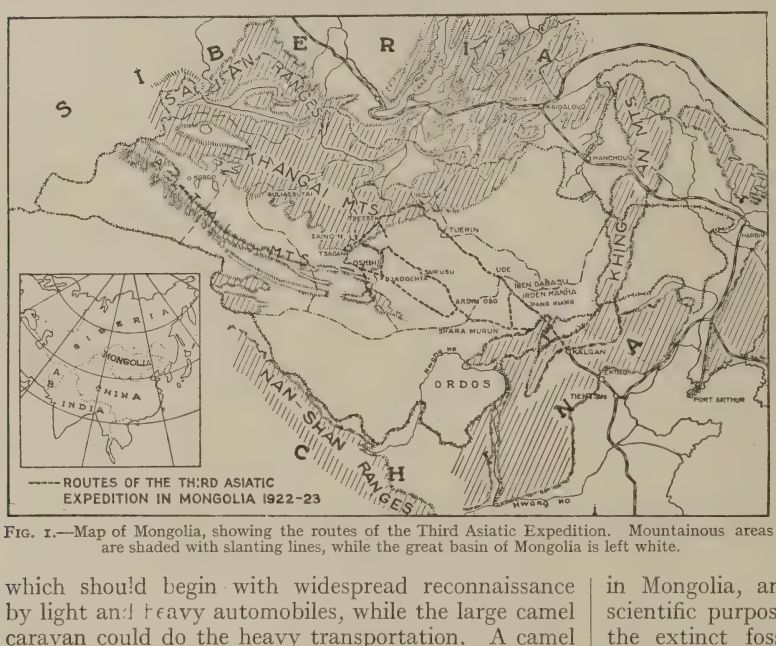

FIG. 1.—Map of Mongolia, showing the routes of the Third Asiatic Expedition. Mountainous areas are shaded with slanting lines, while the great basin of Mongolia is left white.

which should begin with widespread reconnaissance by light and heavy automobiles, while the large camel caravan could do the heavy transportation. A camel caravan travels two and a half miles an hour, fifteen miles a day; a well-equipped automobile train is capable of ten times this speed. This plan promised a double advantage over the work of previous explorers who had crossed the Gobi with only a camel transport, namely, Raphael Pumpelly (1864), Ferdinand von Richthofen (1877), and V. A. Obruchev (1894–96).

In the year 1920 Mr. Andrews submitted the plan to the president and trustees of the American Museum of Natural History, chiefly with the hope of putting to the test the theory advanced by the present writer in 1889 and 1890, that the high plateau region of central Asia would be found to be the chief homeland or centre of origin, evolution, and distribution of the great orders of mammals. With this main stated object and the discovery of the principal centre of human origin as the chief popular object, Mr. Andrews aroused widespread public interest and succeeded in financing the expedition for a five-year period, 1921–26. The first year, 1921, was devoted to organisation in China and Mongolia, to the assemblage of the scientific st and the *matériel* of the expedition. The second ye 1922, was given to a three-thousand-mile reconnaissan in the Gobi Desert and, for a short time, in the Khan Mountains north of the desert. The third year, 19 was given to intensive exploration in five of the m promising fossil-bearing formations discovered in 19

The 1922 party left Kalgan, northern China, April 20, according to programme, as follows: R Chapman Andrews, leader and zoologist; Wal Granger, chief palæontologist; Charles P. Berk chief geologist; Frederick K. Morris, assistant g logist and topographer; S. Bayard Colgate, mo expert in charge of three light and two heavy au mobiles; J. B. Shackelford, photographer. A ca caravan train of seventy-five cam left two months earlier and join the party in the centre of the G Desert. The entire personnel cluded twenty-three men—six Ame cans, eight Chinese, nine Mongolia By the perfect organisation a combination of the modern a more ancient methods of des transport, the party made a thr thousand-mile reconnaissance in t five months' season of 1922, to t north, to the north-west, south, a south-east, practically skirting t entire desert of Gobi east of t Altai Mountains, but leaving certa regions east of the Urga trail st unexplored.

Both the mechanical and t scientific plans of the expediti involved many hazards, becau automobiles had never previous been used in scientific explorati in Mongolia, and the accomplishment of the ma scientific purpose of the expedition by discovery the extinct fossil life of Mongolia and the remai of prehistoric man was at best extremely doubtf In all the early explorations, and even in more rece geological work, no land fossils had ever been foun with the exception of a single fragmentary rhin ceros jaw with two teeth, which was brought back b Obruchev.

The palæontological and geological results of t first year's reconnaissance were not only encouragi but also very surprising—in fact, they far exceed our fondest expectations. Only three days aft starting, the first bones of Baluchitherium were di covered in the Houldjin gravels, where Obruchev ha found the fragmentary rhinoceros jaw. A day late April 24, the rich dinosaur deposits of Iren Dabas 260 miles north of Kalgan, were located. On April 2 were discovered the rich upper Eocene titanothe zone of Irdin Manha and the Irdin Manha formatio by far the most extensive fossiliferous upper Eoce deposit known. The party journeyed north and wes the geologists recording a complete cross-section

the rock structures traversed and determining te geologic history of the region. The great bathylith r central Mongolia was determined by Berkey and rris in the traverse extending northward from algan and westward to the Altai Mountains. For is granitic mass, the dimensions of which seem to mpare favourably with the greatest bathyliths thus r known in other parts of the world, the name "the reat Mongolian Bathylith" is proposed. Above the thylith is found an unconformity, covering early alæozoic time; then a second unconformity between alæozoic and Mesozoic time; finally "the Great nconformity" which marks the close of Jurassic me.

From Jurassic time on, Mongolia has been continuously a continental surface, on which a series of more or less extensive *epicontinental* deposits were laid down. These epicontinental deposits extended in time from the base of the Cretaceous to the Pleistocene. The old rock floor which the bathylith invades includes deposits which range from the ancient Archæan gneisses to late Proterozoic graywackes and limestones which may well correspond with the Nan-K'ou series of von Richthofen. The epicontinental deposits above the old rock floor appear to correspond with the "Gobi Series" of Obruchev.

The technical, geological, and palæontological work of the expedition, largely accomplished in 1922, and continued and verified in 1923, was to analyse the "Gobi Series" of Obruchev into its component formations, beginning in lower Cretaceous time and extending to the close of the Tertiary. In every instance the geologist and topographer, and the four palæontologists worked together, and the rapid succession of important discoveries demonstrated over and over again the value of hand-in-hand work of highly trained field geologists and highly trained field palæontologists. The training of Prof. Berkey in the very difficult pre-Palæozoic and Palæozoic geology of the eastern United States was no less valuable than the quarter century of field experience in the deserts of western United States on the part of Mr. Granger and his able fossil-hunting assistants, Messrs. Kaisen, Olsen, and Johnson.

In the case of each of the three Cretaceous zones, only a single guiding fossil was found in the first season, namely, the skull of the primitive horned dinosaur Protoceratops and the skeletons of the two primitive iguanodonts, Protiguanodon and Psittacosaurus. The discovery of each of these guiding fossils required the sharpest vision and the most prolonged field training.

Fig. 2.—Members of the 1923 party of the Third Asiatic Expedition in camp at Irdin Manha. Middle row, left to right: Walter Granger, Prof. Henry Fairfield Osborn, Leader Roy Chapman Andrews, Frederick K. Morris, Peter Kaisen; top row (Americans), left to right: C. Vance Johnson, Albert F. Johnson, J. McKenzie Young, George Olsen. Two of the young Chinese members—Buckshot (front row, third from right) and Liu (top row, extreme right)—are now at the American Museum being trained as expert preparators. (Photograph by Walter Granger.)

Work during the season of 1923 on the Protoceratops zone proved it to be one of the richest and most remarkable dinosaur deposits of the world. It yielded seven clusters of the now famous dinosaur eggs, four of which were found *in situ*, apparently as they had been deposited, seventy-one skulls and several skeletons of Protoceratops, the ancestor of the great horned dinosaurs of Montana, and three new carnivorous dinosaurs, Velociraptor, Oviraptor, and Saurornithoides. This zone promises the complete life of mid-Cretaceous time in this hitherto unknown continent.

Altogether, eleven chief life zones were discovered in the season of 1922, and a twelfth zone in the season of 1923. In descending order these are as follows:

Pleistocene	OLAN and DISKE, containing *Elephas* and *Rhinocerus*, reported by J. G. Andersson.
Upper Pliocene	HUNG KUREH, 2000 feet, containing the stag *Cervus*, antelope *Hipparion*, camel, beaver, mastodon.
Miocene (?)	PANG KIANG, 500 feet, containing fragment of a rodent jaw, near *Ochotona*.
Lower Miocene	LOH, containing primitive mastodons related to those of the lower Miocene of France, and a rhinocerid.
Oligocene	HSANDA GOL, 3000 feet, containing the giant *Baluchitherium grangeri*, 19 genera of carnivora, rodentia, insectivora resembling those of France and the Rocky Mountains; also ancestral types of the cattle, deer, and pig family.
	HOULDJIN, containing *Baluchitherium*.
Lower Oligocene	ARDYN OBO, 500 feet, containing fauna similar to that of the Oligocene phosphorites beds of France—*Cadurcotherium*, *Schizotherium*, *Cynodictis*, *Eumeryz* (possible ancestor of the deer family).
Upper Eocene	SHARA MURUN, 300 feet, a mammal fauna resembling that of northern Wyoming and southern Dakota—*Protitanotherium* almost identical with species of northern Utah, long-limbed *Ceratherium*, and other mammals.
	IRDIN MANHA, 50 feet, vast flood plain rich in mammals closely resembling those of the upper Eocene of the Rocky Mountains, including carnivores, insectivores, numerous species of titanotheres, and great herds of a diminutive lophiodont. Here occurs the giant primitive carnivorous animal, *Andrewsarchos*, named after the leader of the expedition; also a new form of the dinocerata named *Eudinoceras*.
	ARSHANTO, at the base of the Irdin Manha, yielding numerous small lophiodonts.
Lower Eocene	GASHATO, 200 feet, apparently lower Eocene.
Upper Cretaceous	IREN DABASU, 150 feet, containing middle-sized *Iguanodon*, and the bird-mimicking dinosaurs.
	DJADOCHTA, 500 feet, life zone of *Protoceratops andrewsi*, a partly Æolian formation, 500 feet, containing rich primitive dinosaur fauna of *Protoceratops* and three types of small carnivorous dinosaurs; *Velociraptor*; *Oviraptor*, a small bird-like dinosaur found resting on top of a cluster of dinosaur eggs; and *Saurornithoides*. In this formation were found the seven clusters of eggs, comprising thirty-five well-preserved eggs altogether. In one cluster are seen what appear to be embryo skeletons, probably of *Protoceratops*. Thus all the growth stages in this primitive horned dinosaur, from the egg to the adult, constitute a series which gives us for the first time the ontogeny of a dinosaur.
Lower Cretaceous	ONDAI SAIR, 500 feet, containing *Protiguanodon mongoliense*, small leaf-eating dinosaur related to the *Hypsilophodon foxi* of the Wealden of England, also paper shales with insect fauna.
	OSHIH (Ashile), 1500 feet, containing small parrot-beaked iguanodont dinosaur known as *Psittacosaurus mongoliensis*, and the sauropod *Asiatosaurus* and theropod *Prodeinodon*.

In these *fifteen* formations, representing at least *twelve* new life zones, the main object of the Third Asiatic Expedition, namely, "to test the theory of the central Asian origin of the mammalian life of Europe and America," has been accomplished. According to Osborn's prediction of 1890, proof has been found of the existence in central Asia of all the great orders and of many families of mammals, excepti those orders which by common consent originat in South America, and the four orders which originat in Africa, namely, the proboscideans, the hyracoi the sirenians, and the toothed whales, according Osborn (1890) and the discoveries of Beadnell a C. W. Andrews (1893). Surpassing the verificati of this prediction as to the mammals, the centr Asian plateau proves also to have been the centre evolution and adaptive radiation of the great divisi of land reptiles known as dinosauria. From this gre home-country of land reptiles and of land mamma from Jurassic time onward, races migrated westwa to Europe and eastward to North America, and th affords the long-desired and complete explanation the community of the fauna of the Rocky Mounta region and of western Europe, in both Mesozoic a Cænozoic time.

It is a very significant fact in the history of pal ontology that the homeland of the mammals duri the Age of Mammals, and of the reptiles during t Age of Reptiles, is the very last to be discovere Beginning with the first palæontological work towa the close of the eighteenth century in Europe, co tinuing with the thorough exploration of Europe a southern Asia during the nineteenth century, and wi the wonderful discoveries in reptilian and mammali history in North America and South America fr the middle of the nineteenth century onward, t homeland was still left untouched and unexplore Discoveries in North America were so extensive a so revolutionary that many thought the homela had been revealed in our great western fossil be Positive claims were advanced by Ameghino Patagonia as the homeland of proboscidea and primat As a result of these discoveries in the western hen sphere, it proves true that several families of mamm did originate in North America and several orders mammals in South America, but the ancestral sto from which these orders radiated is to be traced the high plateau region of Asia, where similar cau prevailed first, in the origin of the terrestrial dinosau second, in the origin of the mammals; finally, may predict, in the origin of primitive man. The climatic and physiographic causes are an elevat country of the savannah type, largely open, part forested, in which there was throughout a seve competition and struggle for existence leading to high varied adaptive radiation.

The season of 1923 differed from that of 1922 in t intensive exploration of five of the chief formatio discovered, namely, Iren Dabasu, Irdin Manha, Sha Murun, Ardyn Obo, and Djadochta, yielding altogeth a great collection of fossils in a remarkable state preservation. These fossils were safely transport a thousand miles across the Gobi by camel carav in charge of Mongol drivers, and through superi technical methods reached the American Museu without the least injury. They are now being work out of the rock by a large force of men in the museu laboratories and are being described by Messrs. Osbor Matthew, Granger, and Gregory in a series of pr liminary papers in *American Museum Novitates* a in more popular form in *Natural History* and *As Magazine*. The perfect state of preservation of t

l bones and eggs, especially those from the Proto- tops zone, is without precedent; it appears as if l-driven sand suddenly overcame large numbers hese animals and buried the nests of dinosaur . Several of the Protoceratops skeletons were d entire; others were partly scattered. The little nal known as *Oviraptor philoceratops* (a name

Dr. Chaney, of the University of California, and an archæologist, Dr. Nelson, of the American Museum staff. The expedition throughout has enjoyed the hearty co-operation of the Geological Survey of China, which has contributed the services of one of its chief members, Dr. Amadeus Grabau, for the work in invertebrate palæontology and palæogeography. The

FIG. 3.—American Museum camp of the 1923 season on top of the lower Cretaceous formation Oshih (Ashile). Above is the Oshih plateau, which gives the region its name. Here were discovered the parrot-beaked iguanodont Psittacosaurus and the giant sauropod Asiatosaurus.

nifying "the egg-seizer with a preference for cera- psian egg diet") was found directly above one of e nests. This terrestrial dinosaur fauna is entirely new science because it belongs to a period known hitherto ly in scattered deposits of littoral formations.

Interest in these discoveries, particularly in the nosaur eggs, has been world-wide and makes evident constantly increasing knowledge of palæontology d anthropology, which is a most hopeful sign for e future. Upwards of ree thousand applica- ons have been received r places on the expedi- on. The original plan of e Third Asiatic Expedi- on was to terminate in 926 with excursions into nexplored portions of orthern Tibet and perhaps f Chinese Turkestan, but e discoveries in Mon- olia led to an import- nt change of plan. Under the very active leader- hip of Mr. Andrews a new scientific and financial ampaign, begun in November 1923, carried on in he chief cities of the United States, has resulted in a ow of contributions for the continuation of the expedi- ion over a new five-year period beginning in 1924. he sum of 254,000 dollars has all been contributed, nd subscriptions are coming from 235 individuals n twenty-five states. One of the leading automobile nanufacturers of America has designed new cars, specially adapted for desert work.

The expedition will return to Mongolia with the riginal personnel, strengthened by a palæobotanist,

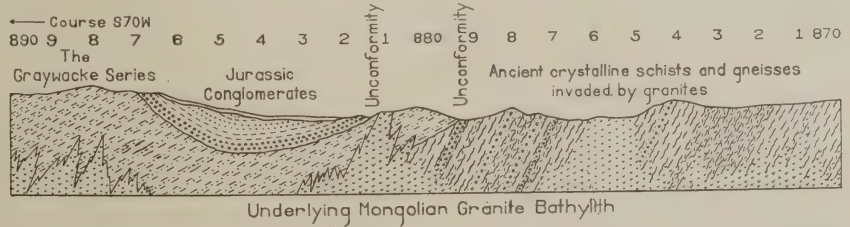
Course S70W
890 9 8 7 6 5 4 3 2 1 880 9 8 7 6 5 4 3 2 1 870
The Graywacke Series
Jurassic Conglomerates
Unconformity
Unconformity
Ancient crystalline schists and gneisses invaded by granites
Underlying Mongolian Granite Bathylith

FIG. 4.—Diagrammatic cross-section of geologic relations at Tsetsenwan. This section lies about 200 miles wes of Urga, where erosion had exposed the granite bathylith and carried away most of its roof of graywack before the Jurassic sediments were laid down. A synclinal remnant of Jurassic conglomerate is preserved here, although several thousand feet of these strata are to be found only a few miles away.

expedition has been favoured by the friendly co-operation of the Mongol Government at Urga, and it is expected that this support will be continued. After seven months of campaign work in America, Mr. Andrews has returned to Peking and will outfit a caravan of two hundred camels to leave Kalgan in December so as to reach the future base of the expedition in western Mongolia in the month of May 1925. From this base, explorations will extend northward and south-westward, carrying the reconnaissance of 1922 into regions not previously explored. The upper Tertiary deposits will, in the meantime, be very carefully explored to test the new theory advanced by Osborn that we must look in the high plateau of Asia or of Europe for the Tertiary ancestors of man. The final publications of the Expedition will appear in a series of volumes entitled "Mongolia and China," of which volume i. will be the narrative of the expedition by Andrews. Volume ii., which will contain the observations and researches of Messrs. Berkey and Morris on the geology and topography, is now in preparation.

The Forces which lift Aeroplanes.[1]

By Prof. V. K. F. Bjerknes, Geophysical Institute, Bergen.

The Direct Geometric Analogy.

THE fields of motion produced by the pulsating and the oscillating bodies are traced out by the registering instrument, and they can then be compared with the corresponding magnetic fields shown, for example, by iron filings. In this way it can be demonstrated that there is the most striking correspondence between the geometric structure of the hydrodynamic and the magnetic field (Fig. 2). The finest part of this geometric analogy, however, which concerns the simultaneously existing impressed and induced fields in the internal spaces, can only be recognised mathematically. There is the same striking resemblance between the hydrodynamic fields of permanent motion, and the corresponding magnetic fields of steady electric currents.

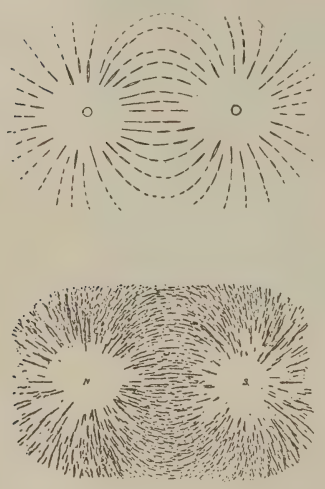

Fig. 2. — Example of the geometric analogy: bodies pulsating in opposite phases and magnetic poles of opposite signs.

One important reservation should be made, however, in connexion with this and the following experiments concerning permanent motion. The theory assumes a frictionless fluid while we make use of the fluid friction as a practical means for producing the required permanent circulation. We have brought in thereby an element not completely contained within our theory: this is important in order that we may recognise later the proper limitations of the conclusion derived from our theory.

The Inverse Dynamic Analogy.

We can also examine the mechanical forces in the two different kinds of field, and it is found that the hydrodynamic force produces attractions, repulsions, lateral displacements, and rotations equal but opposite to those which the corresponding magnetic force produces.

The analogy may be pursued in the most minute details. In all cases we have attraction by oscillations which are symmetrical, and repulsion by oscillations which are anti-symmetrical with respect to a plane, just as in magnetism we have attraction in the case of symmetry and repulsion in the case of anti-symmetry.

Passing on now from the analogy concerning vibratory motion to that of permanent motion, two cylinders rotating in the same direction repel each other so soon as they have had time to produce by friction the required circulating motion of the water. This corresponds to the attraction between electric currents in the same direction. Changing the direction of rotation of one cylinder, the repulsion changes into attraction as soon as the new motion has had ti to develop itself. This corresponds to the repulsi between anti-parallel electric currents.

Theoretical Aeroplane.

When my father had shown his experiments he w often asked if he could not imagine practical applic tions of them. He always answered, "That is n my affair." But if then the inquirer, half excusi his question, added, "The forces are perhaps too feel to be of any use," he always got the answer, "Fro that point of view there is no objection. There is limit to the strength of the forces."

Returning to this question now, forty to fifty yea later, we at once see an application of the last illustr tion, namely, that with the rotating cylinders. T experiment succeeds equally well in air and wat The force will be reduced in proportion to the densit but for this we can compensate by increasing the spe of rotation. One cylinder is displaced normally to t wind produced by the other, or normally to a wi produced by any means, just as an electric current displaced normally to a magnetic field however the fie may be produced: the rotating cylinder is displac towards that side where the circulation round it assis the external wind, while the current is displaced towar that side where its own field opposes the extern field.

We can then use our rotating cylinder to ascend the air. Given a horizontal wind, let the cylinder l placed horizontally and normally to the wind ar rotated so that on its under side it moves against ar on its upper side with the wind. Provided we preve it from being carried along with the wind, it will th be pushed upwards as if attracted by an opposite rotating cylinder higher up. Using the analogy v may calculate the force per unit length of the cylinde To avoid unnecessary complications we use Heaviside rational electromagnetic units. Then the hydr electric current i equals the line-integral of the hydr magnetic force, *i.e.* of the specific momentum, along closed curve round the cylinder. Taking the consta density ρ of the air outside the integral sign we g $i=\rho\Gamma$, Γ representing the circulation round the cylinde And multiplying by the hydro-magnetic induction, i. the velocity v of the wind, we get the force per un length of the cylinder:

$$F=iv=\rho\Gamma v.$$

The formula will be exact if for Γ we take the circul tion actually produced in the free air. But not know ing this circulation we may try as a first approximatio to identify it with that of the circumference of th cylinder, fully recognising that we do not know to wha extent friction is able to transfer this circulation to th air. Let then the cylinder have a periphery of metre and a circumferential velocity of 1 metre pe second. This will give unit circulation in the metre ton-second system. If, further, the wind has th strength of one metre per second, and if we put th density of the air for simplicity equal to 1/1000, we hav

[1] Continued from p. 474.

each metre of the cylinder the lifting force of

$\frac{1}{1000}$ M.T.S. force units $= \frac{1}{10}$ kilogram.

cylinder of ten metres length will then carry a kilogram. If we increase the circumferential velocity from 1 to 10 m. per second, the cylinder will carry 10 kg. If then we increase the wind velocity from 1 to 10 metres per second, it will carry 100 kg. Retaining the angular velocity and increasing the circumference of the cylinder from 1 to 10 metres, we get a lift of 100 kg., and so on.

Instead of letting the cylinder mount in the wind we can move it against the resting air. We then get an aeroplane having a rotating cylinder instead of the aeroplane wings, and as our calculations have shown, it should be a very effective aeroplane from the point of view of lift if only a small fraction, such as the half or even the fifth part of the circulation of the cylinder, be transferred effectively to the air. But only experiments can give full information of this effectiveness.

The technical difficulties of such an aeroplane, however, are obvious. The main interest is, and will probably remain, theoretical: it is a mental instrument illustrating the dependency of flying upon the hydrodynamic actions-at-a-distance, just as Carnot's thermodynamic engine illustrates the dependency of the steam-engine upon the second law of thermodynamics. To see the relation of this, theoretically the simplest aeroplane, to the real aeroplane we must go to the results obtained by experimental work in the aerodynamic laboratories.

Automatic Production of the Lifting Circulation.

Here we meet with effects of friction which are not contained in the theory developed. We started with the paradoxical result that a spherical body moving in uniform velocity through a frictionless fluid experiences no resistance according to the solution of the hydrodynamical equations. What is then the origin of the resistance always experienced, which seems to be far too great to be explained merely as a direct effect of the small viscosity? The general reason has long been known: it is the formation of a wake of eddies. The origin of these vortices has been investigated especially by Prandtl and his school in the aerodynamical laboratory in Göttingen.

As demanded by theory, the vortices never originate in the free fluid. But however small the viscosity of the fluid may be, there will always be a thin layer close to the surface of the body in which the fluid masses are subject to an intensive shearing effect. This disturbs the symmetry of the motion which should otherwise exist between the front and the back of the cylinder (fig. 3). Retarded fluid masses gradually accumulate behind the cylinder, forming there two vortices. From time to time these vortices are carried away, alternately from each side, producing the eddying wake (Kármán's experiment). The resistance experienced by the cylinder is due to the work done in forming these eddies.

Now let us replace the circular cylinder by an elliptic one, set obliquely to the current. The symmetry being lost, the leeward and the windward vortices are formed under different conditions, and more especially, the conditions for their discharge are different. The windward vortex is carried away with the current, while the leeward remains anchored to the cylinder, forming a circulation round it. The lifting effect upon the inclined plane comes exclusively as a consequence of the circulation thus formed round it—a fundamental fact in aerodynamics first recognised by Lanchester, and put into a formula by Kutta and Joukowski. This formula is the same as that which we have just deduced from the hydrodynamic analogy to the electromagnetic field, and, as seen from this analogy, it is valid for all cross-sections of the wings and for circulations of any origin, not merely for the circular cross-section of the rotating cylinders in our theoretical aeroplane.

The difference between our theoretical aeroplane with its rotating cylinder and the practical aeroplane with its inclined wings reduces to this: with the rotating cylinder we produce systematically, in a way which

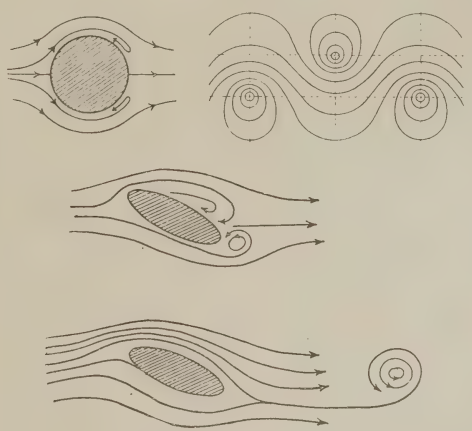

Fig. 3.—Different cylinders in a current.

we can control, the circulating motion which is the condition for lift. By the ordinary aeroplane wings the lifting circulation is produced spontaneously by the asymmetry of the wing.

Induced Resistance.

From the hydrodynamic analogy we have deduced the force lifting an aeroplane. In addition to the lifting force the aeroplane is subject also to head-resistance of which the analogy gives us the theory. Every vortex which the aeroplane leaves behind in the air represents a hydro-electric current which exerts its action-at-a-distance upon that main hydro-electric current which carries the aeroplane.

Fig. 4 shows diagrammatically the system of vortices which every aeroplane must necessarily leave behind itself: namely, the windward vortex which at the moment of starting is carried away from the aeroplane, and the vortices with axes parallel to the wind which join the ends of this vortex with those of the leeward vortex that remains anchored to the wing and carries the aeroplane. This gives a closed vortex having the form of a rectangle of which two sides are constant in length, while two increase with the velocity of the aeroplane relatively to the wind. What the aeronautical engineers call the induced resistance may be regarded

as the hydro-electric attraction of that part of the vortex system which is left behind in the free air upon that part which is anchored to the wing. The analogy with electromagnetism allows us immediately to write down formulæ for this attraction.

The theory of hydrodynamic actions-at-a-distance, which has hitherto been so absolutely useless from a

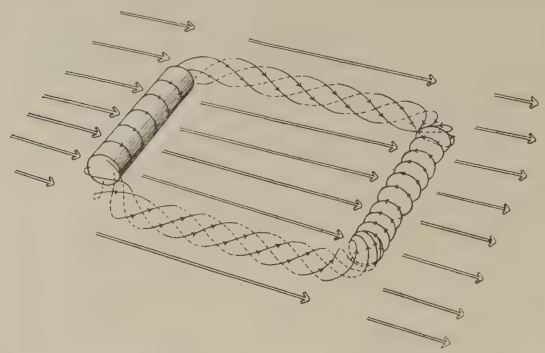

FIG. 4.—Vortex system set up by an aeroplane.

practical point of view, has recently become very practical. It opens up the possibility of applying electromagnetic formulæ to the theory of aeroplanes.

Moreover, it is a short step from the theory of the wing to the theory of the propeller. The fact that its motion is circular instead of translational is of no importance. The force exerted against the propeller blade depends upon the circulation produced round and can be calculated by the theory of the hyd dynamic actions-at-a-distance. From the prope blade the way is not far to the turbine blade. T type of driving force will remain the same whether t driving medium be incompressible water or expandi steam. In the latter medium, effects of expansion v come into play of the kind exemplified by the expe ment with the pulsating bodies. But the greater t complications, the more complete is the use which h to be made of the theory of the hydrodynamic actio at-a-distance.

It is not least interesting from this point of view consider the transfer of mechanical to electrical ener or vice versa. Let us suppose that at one end of shaft we have a water or steam turbine, at the other e a dynamo. At the turbine blades the hydrodynan actions-at-a-distance are in activity, and in the dyna the equal but opposite electromagnetic actions. W derive both of them by the same formulæ, only wi a change of sign when we pass from one set to the oth One set of forces is like a reflected image of the othe

Do we not here behold a deep harmony of Nature a point where important practical problems are int twined with ideas of deep theoretical interest? Final what does Nature mean by placing us face to fa with this wonderful harmony between such differe branches of physics as hydrodynamics and electr dynamics? This is a question which may be answer by a future Faraday.

Obituary.

VISCOUNT LONG OF WRAXALL, F.R.S.

LORD LONG of Wraxall, whose death occurred on September 26 at seventy years of age, was well known to British workers in several scientific fields. He will be particularly remembered for the unswerving support which he gave to scientific advisors while president of the Board of Agriculture in 1892–1900, as regards the necessary measures to extirpate rabies from the British Isles. At that time it had been proved beyond doubt that hydrophobia was a specific infective disease which did not originate *de novo*, but could only be introduced into a district or country by being passed on from animal to animal. Acting upon this and other knowledge when president of the Board of Agriculture, Lord Long was responsible for the issuing of muzzling orders for dogs, first for London and then for the whole country. The National Canine Defence League thereupon instituted a public campaign against the muzzle and condemned the measures wisely adopted by the Board. Lord Long, however, had instructed himself thoroughly well in the whole question of rabies, and, with laudable firmness, he resisted the outcry and the repeated assaults of the uninstructed sentimentalists. As a result, he was able to demonstrate that, by the strict carrying-out of muzzling orders, rabies could not only be checked but also reduced eventually to extinction. The eighty thousand "dog-lovers" who petitioned for Lord Long's dismissal from his office at the Board of Agriculture showed themselves to be poor friends of dogs by their action, which many of them must afterwards have regretted. In recognition of his work on behalf of science, Lord Long was elected a fellow of the Royal Society in 1902. He was also an honorary LL.D. of the University of Birmingham.

DR. R. S. WOODWARD.

DR. ROBERT SIMPSON WOODWARD, formerly preside of the Carnegie Institution of Washington, died June 29, aged seventy-four, and the following accou of his scientific work is taken from the Journal of t Washington Academy of Sciences. Dr. Woodward w born at Rochester, Michigan, July 21, 1849. Followi his education as a civil engineer at the University Michigan, he served with the U.S. Lake Survey, t Transit of Venus Commission of 1882, the U.S. Ge logical Survey, and finally the U.S. Coast and Geodet Survey. Leaving the Federal service in 1893, he b came professor of mechanics and mathematical physi at Columbia University, New York City. In 1905 succeeded the late Daniel Coit Gilman as president the Carnegie Institution of Washington, then but r cently founded by Andrew Carnegie. Dr. Gilman term of office as its first president had been very sho and the real responsibility for formulating the worki plans for the development of a new and comparative untried form of research institution fell upon D Woodward. Following fifteen years of successful a ministration in this office he retired from active du in January 1921. He was president in 1900 of t American Association for the Advancement of Scien and had also served as president of the America Mathematical Society, the Washington Academy Sciences, and the Philosophical Society of Washingto He was a member of the National Academy an other national organisations. Dr. Woodward mad notable contributions to mathematical physics an astronomy, especially as applied to geodesy an geophysics.

Current Topics and Events.

On September 27 Ivan Petrovich Pavlov, the great Russian physiologist, celebrated his seventy-fifth birthday, and it is gratifying to learn that he is still in the full force of his mental power and physically strong, working hard at various physiological problems. His birthday is indeed an international event. Prof. Pavlov's scientific work can be divided clearly into three periods: study of the heart and blood circulation (1877–1890), investigations on the digestive system (1890 until about 1905), and research on the physiology of the brain (the last period). This distinctness in the division of his life was made consciously and is not accidental. The present writer remembers a conversation in Prof. Pavlov's laboratory during tea time, when methods of increasing the productiveness of scientific workers were being discussed. After different ideas had been suggested by his pupils, Pavlov smiled and said, "Well, from my experience, the problem seems very simple, although hard to perform. There is only one method; concentrate all the powers of your soul and body on one idea, which you investigate. Stick to it for many years, think of it daily and dream about it during your sleep. That's all." The results of Prof. Pavlov's work in the three departments of physiology he has studied are brilliant. He has discovered many important facts in the physiology of the heart and circulation of the blood, chiefly concerning the vago-sympathetic innervation of the cardio-vascular system. His investigations on the physiology of the digestive processes have changed completely our ideas on this subject. The secretory innervation of the stomach and pancreas, and the discovery of the laws governing the secretion of the digestive juices by the use of fistulas, are the most important results of his and his pupils' work. Finally, Pavlov crowns a long life, which has been devoted to science, by investigating the physiology of the brain. He is now in the course of writing a book summarising the great results of this work, which he has obtained by means of a simple but ingenious method of conditional reflexes. For Russia, Pavlov is especially precious not only as a scientific worker of great distinction but also as an example to young Russia at the present time. During 1920 and 1921 he and his family suffered badly from lack of food. He was obliged to spend valuable time in domestic work and in searching for food and fuel. In spite of this, Pavlov continued his work, at that time in unheated laboratories, hungry himself with hungry pupils, giving an example of a truly great man, who lives for one thing only—the pursuit of truth.

The retirement of Prof. F. O. Bower from the Regius chair of botany in the University of Glasgow reminds us of the remarkable developments for both teaching and research which have marked the past forty years. During the long tenure of his chair, Prof. Bower has taken a conspicuous part in raising the standard of biological teaching and research in British universities to the high position which it holds to-day. The beautiful laboratories erected in Glasgow under his direction were indeed the material expression of the ideals born during his earlier associations with such men as Sachs, Vines, and Marshall Ward. In those days it was almost a belief that many of the manifestations of life which the microscope had revealed could be observed only in German laboratories. The removal of such views liberated botanical inquiry in Great Britain from the narrow courses of pure systematics. The widespread enthusiasm for biological investigation along lines not yet explored left their deep impression on a highly responsive mind and gave us a man of vigorous frame whose enthusiasm for the problems of plant-structure was coupled with a conspicuous power of exposition.

It may not be widely known that Prof. Bower was among the first of living botanists to deliver a course in botanical physiology in Britain. His investigations into those problems of structure and affinity of Pteridophytic plants, and their presentation in a long series of memoirs, are widely known and appreciated. It has been a pleasure to those who have known Prof. Bower at work to see his reliance on such simple apparatus and laboratory methods as have been the bare essentials to his investigations. As a teacher he will be long remembered. An army of enthusiastic students of medicine has passed under his influence in the University of Glasgow. Their instruction in the broad principles of life as illustrated by the plant-kingdom has been to him a peculiar responsibility and pleasure. As a teacher of advanced students he displayed those high qualities of presentation and a love of argument and reasoning which have so fully marked his scientific writings. To the retirement which Prof. Bower is now seeking he will carry not only the highest appreciation of those who have been privileged to work with him and to know him, but also of the many who have been quickened by the great philosophical considerations regarding the problems of life which have been the mainspring of his work.

After twenty-four years' work, Mr. Ling Roth, who is in his seventieth year, has resigned the keepership of Bankfield Museum, Halifax, owing to ill-health. Acting on the fact that Halifax is a textile manufacturing town surrounded by towns carrying on various branches of the textile industry, Mr. Ling Roth judged that an historical collection of textile tools might be useful, educational, and interesting to the town; and he has succeeded in gathering together a fascinating assembly of specimens of primitive textile tools from many parts of the world. The grouping begins with a selection of basketry followed by samples of matwork, including mat looms in which the filaments are not spun. Then follows a series of implements for spinning with spindle only, spindle and distaff and hand-spinning machines, ending up with an old local wooden hand-spinning jenny which was in use so late as 1916. The collection of hand looms

and rug looms is large and varied both in character and origin and includes two recently acquired and so far undescribed braid looms from China. There is also a considerable series of spools and shuttles, with a set showing the process of manufacture, and one wall case with specimens illustrating the development of the shuttle. From plain cloths we come to patterned cloths and embroideries, and finally there is a collection of the embroidery tools used by ladies of the eighteenth and nineteenth centuries and a rare selection of ladies' work-boxes and their muneries and often exquisite fittings or tools. The whole forms a unique collection such as exists nowhere in any other museum, and gives the visitor or student a clear survey of the tools used in the industry from its very beginnings up to the period when power spinning and weaving came into being.

MR. J. C. MOUTTON, of the Residency, Kuching, Sarawak, directs our attention to a "General Report on the Fisheries of British Malaya," published at the Government Printing Office in Singapore, in 1923. There Mr. David G. Stead writes: "In making this essential appointment [Superintendent of Fisheries Investigation in Malaya] I recommend the Government to give the fullest encouragement to the great College of Fisheries of Seattle, Washington (United States of America), or to the Stanford University of California, to offer a candidate for the position. . . . If only a marine biologist had been wanted I would have unhesitatingly recommended to the Government to make an appointment from amongst the scions of one or other of the universities of Great Britain—but however good may be (and undoubtedly is) the training given in biological work in these institutions, there are none of them, unfortunately, specialising to any great extent in applied fishery work." Now an institution that trains investigators can only become "great" and well known by reason of the work done by its past students, and the College of Fisheries at Seattle, Washington, U.S.A., has still to become famous, judged in this way. It is, in fact, only a few years old. Thus a comparison with the British university training schools cannot be made. But, for any work in fishery investigation, the essential training is that in marine biology and oceanography. That can be obtained at Liverpool or Cambridge, and at the Plymouth or Port Erin Biological Stations, in a perfectly satisfactory manner.

IT is true, as Mr. Stead suggests, that no British university has a Fisheries College attached to it, but those with experience of what fishery investigation involves know that this kind of training can best be obtained, by actual post-graduate work, at the Marine Biological Stations, at the official fishery laboratories, and at sea with the fishery investigation vessels. All these opportunities exist and are used in the training of fishery workers. The ordinary period of time required for an honours degree in marine biology and oceanography is certainly not too long for a really useful knowledge of those subjects, and the man who intends to superintend fishery investigations ought to have this knowledge, as well as practical experience of the special methods of research and of the actual conditions of the fishing industry. At present t training can be obtained at British universities, biological and fishery laboratories, by actual cont with the industry at the fishing ports, and on boa fishing vessels. It can probably be so obtain better than anywhere else in the world, and it is t kind of preparation for investigation of fish problems that is expected by Government depa ments concerned with the administration of t industry.

THE Western Union Telegraph Company has lit fear that the new developments in radio communic tion will seriously affect the traffic by submari cable. The Company has just completed laying a cat between New York and the Azores, a distance 2400 miles. It was manufactured and laid by t Telegraph Construction and Maintenance Compa of London. It is interesting to remember that t Company laid the original Atlantic cable. The ne cable marks an epoch in the development of su marine signalling. To borrow a "telephone" phra it is "uniformly loaded" with a band of that high magnetic material called by the Western Electr Company, which first introduced it to enginee "permalloy." It is an alloy of nickel and iro This band enables signals to be sent six times quick than with an ordinary cable. It is expected th 1500 letters a minute will be transmitted when t cable is in full working order. It is to be used wi an ordinary cable made by an Italian compa which will connect the Azores with Italy. When th is completed, submarine communication betwe Southern Europe and North America will be esta lished for the first time.

WE learn from the Paris correspondent of *T Engineer* that the decree authorising a French gover ment concession for the construction of a tidal pow generating station at Aber Vrac'h, near Brest, to t cost of which the State will contribute in a lar proportion, has been published. While the Ab Vrac'h scheme is mainly experimental, it is intend to pay its own way and will provide Brest with curre by a high-tension main of 30,000 volts, and to ensu a regularity of supply the tidal power plant will wo in conjunction with a power station utilising a hea of water provided by a barrage across the mouth the river Diouris. The Aber Vrac'h barrage will b 150 m. long and from 12 m. to 24 m. wide, and wi be composed of three concrete caissons containing th reversible turbines and alternators. A sluice ga will permit of the basin above the barrage being fille by the rising tide. The turbines will run from nin to eleven hours each tide. Spare chambers are to b reserved in the barrage for carrying out experiment with different kinds of turbines, with the idea attacking any problems that appear to present diffi culties in the utilisation of tidal power. The powe station will not ensure an uninterrupted supply o current; this will be provided for by the Diouri river barrage with a head of from 8 m. to 24 m. an actuating four turbines, each of which will develo from 75 horse-power to 1200 horse-power accordin to the tides.

RCHÆOLOGISTS and others who are interested in h history and topography of Great Britain will ve come the admirable map of Roman Britain which as been issued by the Ordnance Survey (price 4*s*.). e scale is 16 miles to the inch. The map shows the ncipal settlements both military and civil, but not gle villas, though a contingent promise is made that is may be included in a later issue. The roads shown re those constructed by the Romans, the trackways hich belong to an earlier system, such as the Icknield Vay, being omitted. The names in use in later times —Vatling Street, the Fossway, and Akeman Street, re the like, for which there is no evidence before the Saxon invasion—are also not shown. This is perhaps one regretted on the ground of their general famil- iarity. Where the course of a road is known with certainty from direct evidence, it is shown by a continuous double line; where it is uncertain, by a broken double line. Roads known to have existed, but for the course of which there is no evidence, are omitted. Modern names are written in italics; ancient names (when known) in Roman capitals. No attempt has been made to restore the coast line, which is known to have differed considerably on the south and east in Roman times, but the existing coast line has been shown.

THE International Commission of Eugenics held its annual meeting in Milan on September 20–22, repre- sentatives from Norway, Holland, Belgium, France, Russia, and Italy being present. The proceedings related chiefly to business matters, to international co-operation with other bodies, and to the publica- tion in Italy of an international "Bibliothèque d'Eugénique" by the Bureau of the Società per Previdenza ed Assistenza Sociale under the auspices of the Italian society. At the same time, the first Italian Congress of Social Hygiene and Eugenics was being held in Milan, at which Major Leonard Darwin, president of the Commission, read a paper on the "Criminal from the Point of View of Eugenics." An interesting feature of this meeting was the presence of the Rev. Prof. Agostino Gemelli, rector of the Catholic University of Milan, who read an interesting paper on Eugenics and intervened in debate with interesting reports of researches in heredity. Birth-control figured largely, probably for the first time in Italy. At the inaugural meeting it was announced that a chair in social eugenics was now to be founded in the new University of Milan, and at the closing banquet a munificent endowment for the same was announced. Prof. S. Patellani, general secretary to the congress, will be the first occupant of the chair.

THE American aviators, leaving Boston on September 8, have completed their voyage of circum- navigation by their arrival at Seattle on September 28, just under six months from the official start on April 8. The crossing of the United States was of the nature of a triumphal procession rather than a serious test of the possibilities of air transport, as might be inferred from the time taken. The only serious topographical obstacle was that presented by the Rocky Mountains.

THE Department of Agriculture of the Irish Free State is requiring an assistant plant pathologist. Candidates must hold the Associateship of the College of Science, Dublin, or a University degree in science, including botany. Applications should reach the Secretary of the Department, Upper Merrion Street, Dublin, by, at latest, October 9.

THE second session of the Liverpool Psychological Society will commence on October 7, when the president, Dr. Betts Taplin, will deliver his inaugural address at the University at 8 P.M. on "The Power of Suggestion." The Society's first session was very successful, and an interesting programme of scientific research has been arranged for the coming winter. Further particulars may be obtained from the Secretary, The University, Liverpool.

APPLICATIONS are invited by the Ministry of Agriculture and Fisheries for the post of an inspector in connexion with agricultural and horticultural edu- cation and research. Candidates must have taken a course in science or agriculture at a university or college of agriculture and had special training in the science and practice of poultry and small livestock keeping, including goats and rabbits. The necessary form of application (returnable not later than October 20) may be had from the Secretary of the Ministry, 10 Whitehall Place, S.W.1.

THE South African Institute for Medical Research, Johannesburg, is undertaking a research into the harbouring of plague by wild rodents, and the specific prophylaxis and therapy of the disease in man. In connexion with the inquiry, applications are invited for the posts of a bacteriologist and an entomologist. The former should preferably be a medical man with special experience of plague; the latter not necessarily a medical man, but, if possible, with special experi- ence in the study of ectoparasites of rodents. Further particulars can be obtained from "Bacteria," c/o the Director, Lister Institute, Chelsea Gardens, S.W.1.

MR. J. W. HAYWARD sends us an account of an unusual display of lightning which he observed in the neighbourhood of Lake Superior, Quebec, on August 31 last. The lightning took the form of an orange- coloured spark the size of a bright star which traced a narrower and whiter irregular line in a horizontal direction across the sky. Just before disappearing, the head of the flash divided into three or four parts which traced out divergent paths. The motion was sufficiently slow to be followed by the eye, and the whole path with its diverging ends remained visible for an instant. This is apparently a case of rocket lightning, an example of which was described by Mr. W. H. Everett in NATURE of October 22, 1903, p. 599.

THE Council of the Institution of Civil Engineers has made the following awards in respect of selected engineering papers published without discussion dur- ing the session 1923–1924: A Telford Gold Medal to Mr. E. H. Lamb (London); and Telford Premiums to Messrs. F. C. Temple (Jamshedpur, India), H. A. Lewis-Dale (London), and Mr. C. J. Gyde (Pretoria). And in respect of papers read at students' meetings in

London, or by students before meetings of local associations during the same period: The James Forrest Medal, the James Prescott Joule Medal, and a Miller Prize to Mr. R. W. Mountain (London); and Miller Prizes to Messrs. H. S. Smith (London) and C. D. Crosthwaite (London), H. C. Toy (Birmingham), F. W. S. Hawtayne (London), E. G. Wilson (North Shields), and W. W. Davies (London).

THE various types of microscopes manufactured by Messrs. C. Baker, of 244 High Holborn, London, W.C., are described and illustrated in a recently issued edition of this firm's catalogue. Instruments suitable for use in biological, metallurgical, and mineralogical work are included, as well as simpler models for science students. With the view of obtaining greater facility of adjustment or increased rigidity or efficiency, modifications have been introduced in several of the firm's well-known models, and standardisation of parts has been effected wherever possible. Full details are given of all necessary optical equipment, including a series of orthochromatic eyepieces recently designed by Lt.-Col. Gifford to give an increased field. A very complete list of mechanical accessories and illuminating apparatus is also given. Amongst the photomicrographic apparatus may be mentioned the Universal Geometric Slide Camera, designed by M J. E. Barnard. In the design of this apparatus t geometric principle has been observed throughou with the result that extreme rigidity can be obtaine and relative movement of any parts avoided wh the apparatus is subjected to vibration.

MESSRS. Percy Lund, Humphries and Co., Lt hope to publish in December the Transactions, four volumes, of the recently held World Power Co ference. The work will include all the papers pr sented at the conference, and contain a synopsis the discussions which followed the presentation the papers. Most of the papers will be illustrated maps, charts, diagrams, and reproductions of phot graphs.

WE learn from Messrs. Adam Hilger, Ltd., 7 Camden Road, London, N.W.1, that the firm h been entrusted with the manufacture of the inte ferometric apparatus with which the metre will established in Japan, in accordance with the la passed in March 1921 by the Japanese Diet maki the metric system compulsory in that country. T apparatus will also provide for the measurement the 5-metre base, which is the foundation of t geodetic survey in Japan.

Our Astronomical Column.

FINSLER'S COMET, 1924 *c*.—This comet has been well observed, and was of at least the fifth magnitude on September 22, when it was visible in considerable twilight. Dr. W. H. Steavenson traced the tail to a length of 15′. The following elements, by J. P. Möller and B. Strömgren, from observations on September 21, 22, 23, are near the truth.

$T = 1924$, Sept. 4·559 G.M.T.
$\omega = 66^\circ\ 26{\cdot}5'$
$\Omega = 79\ \ 5{\cdot}8$ } 1924·0
$i = 121\ \ 59{\cdot}8$
$\log q = 9{\cdot}61047$

EPHEMERIS FOR GREENWICH MIDNIGHT.

		R.A.	S. Decl.	$\log r$.	$\log \Delta$.
Oct.	6.	$15^h\ 12^m\ 6^s$	$7^\circ\ 51'$	9·9446	0·1688
,,	10.	15 22 12	10 39	9·9804	0·2033
,,	14.	15 31 0	13 2	0·0132	0·2347
,,	18.	15 38 36	15 6	0·0433	0·2633

The comet will be difficult to observe, being in the evening twilight, and low down. It is, moreover, fading rapidly.

RELATIVE NUMBERS OF STARS OF DIFFERENT SPECTRAL TYPES.—Many valuable papers on stellar statistics have been published. One of the latest is by K. G. Malmquist (K. Svenska vetenskaps. Handlinger, 3rd series, Band 1, No. 2) on the distribution of absolute magnitudes. The author adopts as his unit of distance the siriometer, which is a million astronomical units, or 4·85 parsecs. He gives as the number of stars of each type in a cubic siriometer in the neighbourhood of the sun:—B 0·005, A 0·033, F 0·300, G (giant) 0·006, (dwarf) 0·830, K (giant) 0·045, (dwarf) 2·100, M (giant) 0·004, (dwarf) more than 2·400; total 5·723.

The table brings out in a striking manner the vast excess of dwarfs over giants. The actual excess is probably much higher than the above figures indicate. Thus, Malmquist gives some 24,000 stars within 10 siriometers of the sun, of which 1 is of absolute magnitude −4, 7 of −3, the number per magnitude increasing to about 4000 in the neighbourhood mag. 8, and then falling off to 30 for mag. 12. Th falling off is probably only apparent, and due to t manner of selection of the stars he used, as a stud of the sun's nearest neighbours suggests that t absolutely faint stars are far more numerous.

It is to be hoped that a decision will be mad between the siriometer and the parsec as units stellar distance. The use of two different system causes needless confusion.

ORBITS OF COMETS.—A Copenhagen circular giv the following elements of Comet 1924 *a* (Reid) fro observations made at the Cape in March, April, Ma

$T = 1924$ March 13·290 G.M.T.
$\omega = 271^\circ\ 20'{\cdot}19$
$\Omega = 113\ \ 59\ {\cdot}57$ } 1924·0.
$i = 72\ \ 20\ {\cdot}36$
$\log q = 0{\cdot}24432$.

An ephemeris is given for September, the estimate magnitude being 10. But as no observation reported, it is probably fainter than this.

Prof. A. Dubiago, of Kasan, gives in *Astr. Nach* 5311 the following elliptical elements of the come 1921 I, discovered by him.

$T = 1921$ May 4·87982 G.M.T.
$\omega = 97^\circ\ 26'\ 32''{\cdot}2$
$\Omega = 65\ \ 59\ \ 8\ {\cdot}8$ } 1921·0.
$i = 22\ \ 21\ \ 20\ {\cdot}0$
$\log q = 0{\cdot}048102$.
$e = 0{\cdot}939585$.
$\log a = 1{\cdot}266949$.
Period, 79·50 years.

The comet was observed from April 24 until Jun 11, 1921, at eleven observatories. It was ill-defined and the probable errors of the observations ar large, but a parabolic orbit appears to be definitely excluded.

The comet is an eighth member of Neptune' family. Five of them, including Halley's, have bee seen at more than one apparition.

Research Items.

Early Christian Legends in India.—Father ...ten, in a contribution to the history of pre-...tuguese Christianity which is published as No. 5 of ... xix., N.S., of the Journal of the Asiatic Society of Bengal, discusses the origin of a number of the ...nds which centre around St. Thomas, his ministra-... and martyrdom in India, and his connexion with ...apore (Malabar). A Latin hymn, dating possibly ...the fourteenth century, refers to the conversion ...the saint of three kings, and goes on to say that ...eretic, pagan, or Jew could live in the city where ... body lay, and that on his feast-day he appears ... administers the sacrament to the faithful, with-...cling it from the unfaithful. The origin of these ...rences is found in the stories said to have been ... at Rome about A.D. 1122 by one Mar John, who ...escribed as Patriarch of the Indies. A descrip-... of the saint's feast by Theodore, *circa* 590, ...orded by Gregory of Tours, compares closely with ...ditions which prevail during feasts in Hindu ...nes and temples. A number of legends are told ...he miraculous attributes and actions of the right ... of St. Thomas. One of the most remarkable ...allels, which must be due to borrowing on one side ...the other, is found in a Mohammedan story ...ting to the Moslem saint Tamim from Covalong, ...r Mylapore, which follows the story of the burial ...St. Thomas in all its main details. The corre-...ndence may be due to an early conversion of ...abar Christians to Islam.

Egyptian Affinities in Indian Funerary Practices.—Dr. Govind S. Ghurye has collected ...ether and published in *Anthropos*, vol. xviii.-xix., ...umber of examples of funerary ritual among the ...ples of India which, in his opinion, even among ...se who practise cremation, point to affinities with ...practices of Ancient Egypt. Among the Nayadis, ...urn in which the calcined bones are buried is filled ...th curds and honey, and butter, sesamum, and ...ley are placed in the burial pit with it. The ...tom of anointing the body with oil, turmeric, or ...r substances, and the use of a new cloth to cover ...before burial or cremation, point to a survival of ...idea of embalming. The Egyptian life-like por-...t of the deceased survives, in accordance with ...principle suggested by Elliot Smith, in the stone ...s in connexion with the rite of cremation, which is ...rded among the higher castes for some time as the ...ge of the dead, and among the lower castes ...erally in an effigy of the dead made of earth, ashes, ... other material. Further, the Proto-Egyptian ...tice of protecting the corpse from the soil by mats, ...t-skin, or other means, and the pre-dynastic "pit ...ve" with its shaft and recessed chamber, each find ...allels in Indian custom. Dr. Ghurye concludes ...giving a detailed list of the directions in which the ...y is orientated in burial and in cremation by ...ous Indian peoples.

Rationale of Radiation Therapy.—The action ...adiations (both radium and X-ray) depends upon ... direct action upon the tissues, varying with the ...nsity of the radiations, (2) an indirect effect ...ced by the action upon the tissues and circulating ...ds. The subject is discussed in the *British ...rnal of Radiology* (B.I.R. section), vol. xxix., ... 289, August, p. 296. There is much evidence ...ch goes to prove that direct radiation of tumours ...duces in some cases an inhibiting effect upon cell ...elopment, and in others the cessation of activity ... the death of the cells. If a sufficient dose of radiations be given to certain tumours a lethal effect upon the tumour cells is induced. But in the majority of cases of tumour growth treated clinically, the administration of a lethal dose to the whole of a large tumour is a practical impossibility, because of the disastrous effects upon the organism as a whole, due to the secondary or reactionary action mentioned above. Other methods of application have therefore to be employed, *e.g.* subjecting the patient to sub-lethal doses extending over a considerable period, with intermittent administrations. "It is clear to most radiologists that the cure of cancer by radiations is at present beyond our reach, and that to claim cure would be to retard indefinitely the progress of radio-therapy in the treatment of cancer. To establish the proof of a definite degree of control upon tumour growth would be a great step forward in the attack upon this intractable disease."

The Life-History of the Indian Glow-worm.—Bulletin 69 of the Department of Agriculture, Ceylon, by Dr. J. C. Hutson and Mr. G. Douglas Austin, is devoted to an account of the habits and life-history of the Indian glow-worm (*Lamprophorus tenebrosus*). This insect is luminous in all its stages from the egg to the adult. The female is of large size (60-65 mm.), and is a pale yellow larviform creature, while the male is a winged insect, 20-30 mm. long. The female lays from 30 to about 100 eggs and broods over them during the incubation period; if removed from her eggs she soon finds her way back and curls up over them. If the eggs be scattered, she usually collects them one by one into a heap again. The incubation period is about seven weeks, and the male larvæ are stated to pass through only three or four instars, while the females have five or six. The larval period for both males and females is eight or nine months, and the whole developmental period occupies less than one year during normal conditions. The species is nocturnal in its habits, both larvæ and adults remaining in concealment during the day. The larvæ appear to feed normally on the African snail (*Achatina fulica*) and probably on other local snails. The African snail is a pest of young plants in vegetable and flower gardens, in some districts of Ceylon, and the larvæ of the glow-worm are probably of some value in reducing the numbers of this mollusc. Observations made in captivity indicate that a male glow-worm larva will destroy 20-40 snails during its life, while the female larva will account for 40-60 snails. The adult male and female glow-worms, however, were not observed to prey upon the snails. The snail has spread to new areas within recent years, and it is possible that the glow-worm is still absent from such districts. Experiments might be made to introduce it into such areas.

Eggs from Infected and Immunised Hens.—H. G. May finds that in hens fed or inoculated with living cultures of three bacteria pathogenic to them (fowl cholera, fowl typhoid, and white diarrhœa), although the ovaries are infected, the organisms do not pass into the eggs. (Bull. 197, Agricultural Experiment Station of the Rhode Island State College, U.S.A.) Agglutinins and germicidal substances were formed to some, but a variable, extent in hens immunised with these organisms, and a small amount of agglutinin passed over into the egg albumin. The albumin of eggs of normal hens in a dilution of 1 in 5 proved slightly germicidal to the organisms, and with one exception there was no increase in germicidal power of the egg albumin after immunisation of the hens.

NATURE OF *BLASTOCYSTIS HOMINIS*.—This is one of the commonest parasites met with in the human intestine, and its true nature has remained uncertain since its discovery some fifty years ago. Though quite harmless, it is of importance as being responsible for mistakes in diagnosis, having been frequently confused with the cysts of the amœba of dysentery. The earlier workers regarded it as a cystic form of various protozoa or as a degenerated leucocyte. Alexieff first put forward the view that Blastocystis is a vegetable organism allied to the Blastomyces group, and now Major R. Knowles and Assist. Surg. B. M. Das Gupta support this (*Ind. Journ. Med. Research*, vol. xii., No. 1, p. 31). They regard Blastocystis as a genus of the higher fungi, closely allied to the Schizosaccharomycetes, and probably containing several different species. The general life-cycle appears to consist of (*a*) multiplication by binary and multiple fission by plasmotomy; (*b*) multiplication by exogenous budding; and (*c*) multiplication by endogenous spore formation inside an ascus into which the paraglycogen mass is converted.

BRANCHING IN BUDDED CACAO.—Cacao grown from seed produces two types of branch with different leaf arrangements, the main axis terminating in five branches, and the lateral horizontal branches, which are of the "fan" type. Cacao plants grown vegetatively from buds are always of the "fan" type. Messrs. S. C. Harland and R. G. Parga discuss this problem in the September number of *Tropical Agriculture*. Their experiments show that budded cacao is always of the fan type because the buds are taken from the horizontal fan branches. If buds are taken from the main axis, the seedling type of tree can be produced, with normal dimorphic branching.

BOTANY OF THE ABOR EXPEDITION.—In the Records of the Botanical Survey of India, vol. 10, No. 1, Mr. I. H. Burkill describes his extensive collections and observations made during the Abor punitive expedition in 1911. The flora is of a highly mixed type, since this region lies on the boundary of the Asiatic cupuliferous zone, and yet contains elements from the tropical Gangetic floras. The Himalayan and Chinese floras also mingle in this vicinity, and these various elements of the vegetation are traced by Mr. Burkill to their origins. On account of its high rainfall, the country is chiefly covered by rain-forest, but a curious feature is the absence of pines on the hills, this being attributed to the high humidity and consequent excessive competition of dicotyledons. The typical rain-forests consist of a main level of animal-dispersed and often large-leaved trees and climbers, above which arise taller, wind-dispersed and small-leaved trees. At levels above 2000 feet the forest changes; Quercus and Castanopsis become dominant and tree ferns scarce. The most striking feature, ecologically, of Abor land appears to be that the type of climax forest is by no means uniform, but it is largely determined by the soil conditions. Thus on the Pleistocene gravels, *Terminalia myriocarpa* forms pure forests, these being nearly devoid of any climbing plants. Similarly, the Dipterocarp *Vatica Shingkeng* makes pure forests on north slopes over Siwalik and Gondwana rocks, an absence of mosses and prevalence of lichens being also a noteworthy feature of these areas.

COLD WINTERS IN SOUTH-CENTRAL EUROPE.—The *Monthly Weather Review* for April has an article by Dr. J. Maurer on "Severe winters in Southern Germany and Switzerland since the year 1400, determined from severe lake freezes." The article is translated from *Meteorologische Zeitschrift* for March by Mr. W. W. Reed of the Weather Bureau, Washington. The da for northern Germany show that in the period fr 1788 to 1845 there was an unusually large number severe winters, while since that period there have be far fewer. In the 58 years from 1788 to 1845 th were 17 very severe winters, and in 72 years from 18 to 1917 there were only 6. In southern Germany a Switzerland the occurrence of severe winters is qu different. From 1788 to 1845 there were only 3. South-Central Europe from 1435 to 1587 there w 15 severe winters in 153 years; from 1588 to 1680 severe winters in 92 years; in 1681 to 1800, 10 seve winters in 120 years; and in 1801 to 1923 there were severe winters in 123 years. It is mentioned that t recent small number of severe winters permits t conclusion that an offsetting will follow, but it difficult to predict when that will commence. T inquiry is said to indicate a kind of "climatic oscil tion" the cause of which lies completely hidde Without doubt cold winters in Central Europe affect a marked degree the severity of the winter in Weste Europe, but the absence of regular periodicity in t German data affords no aid for forecasting.

POLYPEPTIDES IN OATS.—Jodidi (Journ. Frank Instit. 198, 1924, pp. 201-211) has estimated t amount of peptide nitrogen in ungerminated oa (four varieties) as 0·03 to 0·1 per cent. of the d weight. Similar figures are given for the amino-ac and acid amide nitrogen.

THE CHEMISTRY OF COTTON.—The Journal of t Textile Institute (vol. 15, No. 8) contains two pape dealing with the chemistry of cotton. Messrs. P. Clifford and M. E. Probert (p. T401) give the resu of an examination of the constituents of the wax fro American cotton. A large proportion of this consis of free wax alcohols, but few wax esters being prese A new sterol, $C_{34}H_{58}O$, was detected and examine In the same number (p. T414), Mr. H. J. P. Ve records the yields of β-glucosane obtained by l pressure distillation of cotton after various trea ments. Raw cotton gives no β-glucosane on d tillation—the water and acid soluble mineral su stances must be previously removed. The highe yield obtained was 37 per cent., and rather low values were obtained for American cotton than f Egyptian, the two varieties differing also in oth respects.

QUARTZ GLASS MANUFACTURE.—The issue of t *Physikalische Zeitschrift* for August 1 contains description by Dr. von Schwarz of the Herberg method, which has been in use for the last 11 years the firm of Goertz, for producing quartz glass f therapeutic and other scientific purposes. The fine divided quartz is melted in an electric furnace which a vacuum is maintained by continuous pumpi until the melting process is complete. The vacuum then replaced by a gas such as carbonic acid gas unc a pressure of 8 to 12 atmospheres, and after a co siderable time the fused quartz is allowed to co The result is a block of quartz containing only minu air bubbles in which the air pressure is as nearly possible that of the atmosphere and therefore produc no elastic stresses in the material. According observations made by Dr. G. Joos and described the same issue, quartz glass made in this way is transparent in the ultra-violet as rock crystal.

KERR'S ELECTRO-OPTICAL EFFECT IN GASES.—T effect was observed in gases by Hansen; but he ma use of ordinary white light, so that his results are n sufficient for testing the different theories of t phenomenon. The simplest conditions prevail in gas, since the molecules are separated from o

ther, and each molecule may be considered as eig acted on by the electric field, and as acting on transmitted beam of light, independently of the t r molecules. Herr G. Szivessy describes the hod employed by him with sulphur dioxide, monia, and carbon dioxide in the *Zeitschrift für ysik* of Aug. 12. A beam of light from a powerful lamp was sent through a monochromator and a rising nicol into a long vessel filled with the gas, between the plates of a condenser inside the el which produced a field inclined at 45° to the ie of polarisation. On emergence the light passed ough a Brace half-shade compensator into the erving telescope. Pressures up to about 1500 cm. nercury were employed, using wave-lengths from 8 to 656 $m\mu$; it was not found possible to study the ct of temperature variation, and the temperature kept nearly constant at about 17·5° C. The ults obtained show that the electrical double action is proportional to the field intensity, eeing with Kerr's law; with constant wave-length r's constant is proportional to the pressure, and h constant pressure is inversely proportional to wave-length.

ONISATION BY POSITIVE IONS.—Dr. J. Franck, in *Zeitschrift für Physik*, Aug. 4, shows that in order ionise another atom by collision the positive ion rst have at least the kinetic energy $\frac{1}{2}mv^2 = 2(I + P)$, were I is the ionisation energy and P is the potential ergy which the first ion and the new ion produced the collision have with regard to one another. I is known for many kinds of atom, and P is approxiately the potential energy which two particles with positive charges possess when their distance apart is the sum of the radii of the atom and of the ion. It may, however, be necessary to take mutual polarisation into account. The number of such collisions is small. Ionisation can take place for smaller kinetic ergy if the ion, instead of ionising by direct collision, ges up its energy to another atom, which then collides with a third, thus ionising it. Collisions tween ions and atoms may excite the atom, which ay then be ionised by collision with another atom. is estimated that the lowest kinetic energy of the ion which can in the end produce ionisation is about I, but the effect will then be very small. The case ionisation due to the collision of ions having large nisation energy with easily ionised atoms is discussed; very small kinetic energy may then produce nisation, as when Hg ions ionise the alkali metals. he phenomenon of the pseudo-high vacuum in pure re gases, and the effect of traces of impurity, epends on the difference between the ionising energy the rare gas and of the impurity. In the pure gas, sufficient number of electrons is not produced near e cathode to allow of discharge; but the positive ns of the rare gas act on the molecules of the purity, producing the necessary electrons.

GLOBULAR LIGHTNING AND THE CAUSE OF THUNDER.—M. E. Mathias, in the *Comptes rendus*, Paris Acad. ci. July 21 and Aug. 18, suggests that in a lightning scharge heavy complicated molecules are formed ndothermically, and that sometimes, when an exedingly violent discharge takes place close to the round where the air is a bad conductor, a short flash ith a relatively large section will be produced, giving cylinder filled with hot, heavy gas. This falls and ontracts in length until it becomes more or less lobular, and it is suggested that even in the case of ases there is some kind of surface tension at the oundary between two different fluids which can roduce this result. The phenomenon was observed h detail by M. Koechlin on May 21 last, the cylinder being dazzling white at first, and the colour changing during the fall to yellow and finally to fiery red. This indicates a cooling of the mass, which finally explodes with a violent crash, the heavy gases suddenly decomposing with the formation of O_2, N_2 and a certain amount of ozone, which gives a characteristic odour. Complex molecules, such as O_{12}, N_{12}, O_6, N_6, O_4, N_4, may be formed by the discharge; and it may be that, even in an ordinary lightning flash, the main detonation of the thunder takes place some little time after the flash, when the heavy gases formed have cooled down sufficiently to explode. At the instant when the discharge takes place, a reduction of pressure is produced along the flash, owing to the formation of complex molecules, and this may cause a crack of sound; but the main detonation comes later, when these molecules suddenly decompose.

MANGANESE STEELS.—The more extensive use of steels containing from 1-1·5 per cent. of manganese has been frequently suggested on account of the superiority of their properties over those of carbon steel, especially when heat-treated. R.D. Report No. 61 from the Research Department, Woolwich, gives an account of an investigation on the properties of medium carbon steel with high manganese content, by J. A. Jones. It appears from his results that after oil-hardening at 850° C. and tempering at 650° C., all the mechanical properties of a 0·4 per cent. carbon steel are improved by the presence of about 2 per cent. of manganese. The improvement is still maintained at 3 per cent., but the additional manganese shows no advantage and may introduce difficulties in forging. Steels with high manganese content are extemely liable to show temperature brittleness when slow rates of cooling after tempering are employed, but this may be avoided by suitable heat treatment. If good impact figures are to be secured, the cooling from the tempering temperature must never be slower than in air. The author finds that the critical points Ac_1 and A_1 are lowered by the increasing amounts of manganese. In this he confirms the work of previous investigators. Ac_3 and Ar_3 are also lowered, and with sufficient manganese merge into Ac_1 and Ar_1 respectively. The presence of manganese tends to prevent the separation of ferrite and pearlite on cooling. For purposes for which it is desired to replace carbon steel forgings by steels of greater strength, the author suggests carbon from 0·35 to 0·40 per cent., manganese from 1·8 to 2·2 per cent., oil-hardened from 800° to 850°, tempering from 610° to 650° C., and cooling in air, oil, or water.

A PORTABLE MICROSCOPE.—In their "Baby London Microscope" Messrs. R. and J. Beck, Ltd. (68 Cornhill, E.C.3), have constructed the most portable microscope yet produced, for it is contained in a case measuring only $5\frac{1}{4} \times 2\frac{1}{2} \times 2$ in. The tripod stand folds up, but when extended the microscope is quite stable. It has a sliding coarse adjustment and an extending draw-tube giving a tube length of 160 mm. The fine adjustment is sufficiently delicate for use with an oil immersion objective and the objective screw is the standard R.M.S. one. The tube similarly takes the standard size eyepieces. The microscope may thus be used with all standard objectives and eyepieces, though it is primarily intended for nature study in the field. For this purpose, a special $\frac{2}{3}$ in. objective is supplied, so that the microscope will pack into its case when it is in position. The mirror is concave and provided with all adjustments, but for high-power work a condenser and flat mirror may be added. Examination of the instrument has justified the claims as to portability and performance put forward by the makers.

The Ascent of Sap and Transport of Food Materials in Trees.

IN opening the discussion on this subject in Section K (Botany) of the British Association, on August 7, at Toronto, Prof. H. H. Dixon affirmed that the cohesion theory of the ascent of sap has recently received important support from the observation of continuous water-columns in the tracheæ of wilted plants by Holle and Bode, from the new determinations of the tensile strength of water by Renner and Ursprung, and from the observations of the collapse of the transmitting wood, and even of its constituent tracheæ under the tension developed during transpiration, and of their recovery on the rupture of the tensile water-columns. The water in the tracheæ, which passes into a state of tension, has been shown to contain carbohydrates and other foodstuffs. When the movement is upward in the tracheæ, due to transpiration and the supply from the roots, these foodstuffs are carried upwards in the stream. If for any reason a downward movement is originated these foodstuffs will evidently be carried downwards. Such a downward movement may be established by cutting a leaf of a transpiring plant under water. The downward movement may be visibly traced by adding eosin to the supply to the leaf. Thus in a short time the tracheæ of the tuber of a transpiring potato plant has been shown to become infected with eosin from one of its upper leaves. In this case transpiration from some leaf-areas has drawn the eosin solution from the cut leaf downwards into the tuber. In a similar manner, we may suppose that the foodstuffs manufactured by the leaves are transported. The reversal of the transpiration stream, artificially produced in the above experiment, probably often occurs naturally. This is suggested by the backward transport of hormones in the wood, recently demonstrated by Ricca in Mimosa, and probably occurring in other cases of transmitted stimuli.

The physical properties of the bast, and its available cross-section, render it impossible to suppose that the transference of foodstuffs takes place in the bast. An increase in the permeability of regions of the mesophyll around certain bundle-endings may render the contents of these cell-masses available as sources from which the tensile sap in the plant draws. It was assumed that the fluid thus introduced into the tracheæ is dragged backwards in the conducting tracts by the transpiration of other parts. Experiments were further quoted showing the change of permeability with temperature, and also the variations in the temperatures of leaves under natural conditions. It was contended that such temperature-changes may be, in part at least, responsible for permeability-changes which originate backward movements in the water conduits, and hence facilitate the distribution of foodstuffs throughout the plant.

In conclusion, Prof. Dixon held that although it could not be affirmed that evidence amounting to a demonstration of the validity of the cohesion theory was available, nevertheless the theory as at present formulated seemed in harmony with the known facts.

In following with an account of recent experiments bearing on the transport of foods in woody plants, Dr. O. F. Curtis stated that when ringing experiments were performed during the growing season, materials necessary to growth would not move upwards through the xylem past the ring. Analyses and cryoscopic determinations indicated that the movement of sugars and other solutes was interfered with by the ring. When, just previous to spring-growth, rings were made at different distances from the tip of a branch, the growth above the rings was roughly proportional to the amount of food stored above the rin Quantitative tests were held to indicate that t upward transfer of carbohydrates had been interfer with by the rings. It was further held that wh the xylem of a given region of the stem was isolat by rings through the phlœm from other tissues whi would normally receive carbohydrates from the wo or supply the latter with carbohydrates, no mov ment of such carbohydrates out of or into this regi of the xylem occurred. It was further stated th the normal upward movement of nitrogen and as constituents was interfered with, though not co pletely stopped, when the phlœm was cut. Th occurred whether the ring was made in the ear spring before new xylem and leaves were formed, in midsummer after growth was practically comple The evidence obtained from ringing experiments w held to indicate that the influence of the ring on t upward movement of nitrogen was independent its effects on the organic content of this part abo the ring or on transpiration.

In more or less direct opposition to the vie expressed by Prof. Dixon, it was finally affirmed th experiments with spiral ringing of stems provi further supporting evidence for the opinion th foods and nutrients travel both upwards and dow wards in higher plants chiefly in the phlœm.

Dr. D. F. MacDougal followed with a detail statement of experiments conducted by the aid of dendrograph. The purpose of his communication w to lay before the section his observations on variatio in volume of trees, and in the movements of liqui within them. He stated that dendrographic measur ments of several species of trees show that the trun undergo variations in volume which may be corr lated directly with the transpiratory activity green surfaces, which in turn varies with the widt of the stomatal slits. The period in which stomat slits are widest is one of contraction of the trunk closure of stomata is accompanied or followed b expansion of the trunks. Contraction of the trunk or stems of mesophytes and sclerophylls takes pla in the daytime; contraction of flattened or cylindric stems of cacti takes place at night and expansion i the daytime, in reverse of the occurrences in the mo general type.

The time or hour at which these two phases variation prevail changes with the season. At th time of maximum growth, contraction in coniferou trees may begin within a half-hour after sunris Such reversible variations are modifiable by change in relative humidity, by defoliation, girdling, toppin or any agency which alters transpiration or rate c conduction, and are explainable on the basis c Prof. Dixon's conception of the mechanism of th ascent of sap. The upward path of moving solution of a basic dye, such as fuchsin, is found to be in th wood formed within the previous two years. Whe two layers are formed in a season conduction i chiefly in the one formed earlier. Whether the othe layers are more available or suitable for the down ward conduction of organic material is yet to b tested.

The amount of reversible variation in the diamete of a young pine may be 1 part in 170; in the uppe part of a tree approaching maturity 1 part in 900 in the basal region 1 part in 1700; in a large roo 1 part in 364. As this variation takes place chiefl in the outer wood, it is found that in such recentl formed layers the coefficient of expansion and con traction may be five to ten times greater than tha of the trunk taken as a whole, as given above.

the discussion which followed Prof. Priestley ...ged that he had been a supporter of the cohesion ...ory of the ascent of sap, but that he was now so ...pressed with Copeland's criticism of the theory ...h he considered the latter incapable of meeting ...y the criticism which it had raised. He desired ...point out that Prof. Dixon had not replied to ...eland's challenge, demanding as it did an explana... as to how energy is employed in raising water ...the stem. He further declared that no plant-...cture had yet been shown to be capable of ...sting the tensions which the cohesion theory ...posed to be developed in the tree.

...rof. Overton expressed himself in general agree...nt with the cohesion theory, while Prof. V. H. ...ckman considered that much work had yet ...be done before a valid theory of the transport ...organic substances could be constructed. There ...e difficulties in admitting that the wood furnished ...ownward path for organic substances, while at the ...ne time it was engaged in transmitting the upward ...spiration stream. In his opinion it seemed ...ily improbable that the bast is without a function. ...Whatever the function of the bast, he felt that it was ...ociated with the downward transmission of food-...iffs.

...n replying to the views which had been expressed, ...f. Dixon stated that in his opinion Dr. Curtis had ...t allowed sufficiently for the plugging arising in ...ged stems. It was pointed out that the results of ...Curtis's experiments on branches with extirpated ...od and on those the bast of which had been removed ...ry, from the arrangements described, be explained ...the known difference of resistance of wood to the ...nsmission of water in a radial and in a longitudinal ...ection. In the opinion of Prof. Dixon the experiments described by Dr. Curtis did not necessarily indicate the transmission of food materials by the bast. Replying to Prof. Priestley it was pointed out that the energy for raising water in plants is applied by the transpiring cells in contact with the upper terminations of the conducting tracts. This energy is supplied by the inflow of heat at the evaporating cells or by the stored energy in the cells themselves. The tensions developed in the water are withstood by the strength of the thickened tracheal walls and by the osmotic pressures developed in the adjoining cells.

In conclusion, Prof. Dixon expressed himself in agreement with Prof. Blackman regarding the need for fuller inquiry on the subject under discussion before any theory of the ascent of sap and the transport of organic materials in plants could be generally accepted. He held that it is quite in accordance with the known structure and properties of the tracheal tissues, that upward and downward currents may be simultaneously passing in adjacent tracts. The small resistance offered by the wood to the longitudinal movement of water, compared with that which it opposes to transverse movement, secures the isolation of these two streams. Lest the unemployment of the bast should be used as a reproach against the cohesion theory of the transport of foodstuffs in the wood, he suggested that the companion-cells are glandular in function, and secrete enzymes which digest the colloids in the tracheæ. The sieve-tubes, he held, may be regarded as temporary reservoirs of these enzymes, while to the cells of the wood-parenchyma and medullary rays may be allocated the functions of introducing these enzymes into the tracheæ and of abstracting food materials from them.

J. McL. T.

Aeronautical Research.

THE issue of the report for the year 1923–1924 of ... the Government Aeronautical Research Com...ittee is of more than ordinary interest, since it ...cords that the desire expressed by the Committee, ...at greater recognition should be given to the claims ...pure research, has been recognised, in one import...t respect, by the reorganisation of the old director...te of research at the Air Ministry into two new ...partments, namely, a Directorate of Technical ...velopment and a Directorate of Scientific ...search.

It is gratifying that the Committee is able to record ...eady progress in the different subjects embraced ...by the science of aeronautics. Research having a ...rect application to aeronautics is financed by the ...Ministry; the remainder, having a more general ...plication, is financed by the Department of ...ientific and Industrial Research.

Investigations on elasticity and fatigue of various ...tals have been arranged in the Universities of ...ford, Birmingham, and Liverpool; investigations ...single-cylinder internal combustion engines have ...en started in the Universities of Cambridge, ...rham, and Manchester, and in the City and Guilds ...ngineering) College. In addition, there are the ...olly subsidised researches carried out at the Royal ...rcraft Establishment, the National Physical Labo...tory, and the Air Ministry Laboratory in the ...perial College of Science and Technology, London.

The general field of work is so extensive that a ...al concentration on specific problems is necessary. ...the year under review, one of the most important ...the problems which has received attention is the ...ntrol and stability of airplanes; the Committee ...stifies concentration on the attempt to secure low-...eed control by the continued occurrence of accidents in which "spinning" is a primary or secondary feature. In this direction, slow but steady progress is recorded. It had been suspected for some time that one of the main reasons for loss of control in a stalled airplane lay in the fact that ordinary ailerons, besides applying a moment to roll the machine, also cause it to turn, which turn eventually introduces moments which defeat the primary action of the ailerons and render them ineffective.

A larger rudder is thought to be a part solution: a rudder of ordinary size may be capable of providing all the turning moment required in normal flight, but may prove inadequate in stalled flight, in that it must become less effective through being shielded by the body when the incidence is large, and because larger moments are required from it in order to balance those set up by the wings and by the ailerons.

The difficult problems of the cause of detonation in engines, and of the steps necessary to eliminate this feature in high-compression units, has been under consideration, and attention has been given to the bearing of American work in this field of investigation. Experimental work on engines has been undertaken in the Government establishments and in the Ricardo Research Laboratory.

The Committee records the Air Council's agreement with the view that a higher standard of technical knowledge in all ranks of the R.A.F., and particularly among squadron officers, is necessary, and states that steps have been taken to organise instructional courses at Cambridge and the Imperial College with this end in view.

The report is of modest dimensions; its form is that of a 50-page paper-covered pamphlet, and its issue price, 2*s.* 6*d.*, through H.M. Stationery Office, seems somewhat high.

Radio Communication and Research in Great Britain.

BY what means is it possible to confine the reception of radio signals to certain well-defined localities? The limiting of the radiation from a transmitting station to moderately definite directions is a *fait accompli* so far as radio signals of short wavelength are concerned, but a full solution of the larger problem is still awaited. If the regulations governing the use of radio apparatus in Great Britain for experimental and research purposes, as set out in the recently issued revised Post Office licenses, were to be taken seriously, it might be imagined that the solution of the problem is quite well known. The futility of attempting to regulate to certain frontier boundaries the transmission and reception of radio signals, as is apparently required by the rule which states that "Messages shall be transmitted only to stations in Great Britain or Northern Ireland," was discussed at some length in the autumn presidential address to the Radio Society of Great Britain which was delivered by Dr. W. H. Eccles at the Institution of Electrical Engineers on September 24. Such attempted restrictions on research work cannot be to the credit of the country or help friendly international relations in any possible way.

The experimental tests which, during the past three years, have been carried out between radio amateur experimenters in almost every civilised country of the globe have undoubtedly fostered a feeling of good fellowship between those workers—a feeling which cannot but be to the good of all the countries concerned. But what, indeed, are foreign amateurs to think of us if in the future we consistently refuse to reply to their signals and ignore all calls addressed to us through a too rigid adherence to the terms of our licenses?

The official ban on communications with stations outside the limits of "Great Britain and Northern Ireland" is not even lifted in the cases of the British Colonies, but fortunately (since it may encourage British Government officials to a wider outlook in due time) such views are not held by other countries, as is shown by the following message recently se to the Radio Society from the Canadian Ra Relay League, a large and influential organisation radio enthusiasts :—

"Please convey our greetings to the Radio Socie of Great Britain with congratulations on their achie ments. We also congratulate the Transmitter a Relay Section [of the Society] on their wonder success in the transatlantic tests, and take this opp tunity of expressing our desire for a stronger affiliati between Great Britain and the Colonies for the gene benefit of amateur radio."

In most countries where experimental radio licens are granted, the facilities given with the license a much greater than they are in Great Britain, but view of the pioneer development work that has be carried out by the radio amateur in recent years, seems scarcely justifiable to attempt to increase t restrictions upon him.

It should be remembered in this connexion that was the radio amateurs who discovered the valuat properties of short C.W. waves for signalling over lo distances. Up to three years ago the commerc companies and most radio engineers thought that t shorter wave-lengths were of no use for long distanc but radio amateurs, particularly in England, Fran Canada, and the United States, gradually extend the ranges across which communication could carried on with these waves until, as a result of t transatlantic tests conducted by the Radio Society Great Britain and the American Radio Relay Leagu the incredulous ones looked into the matter. Sin those tests the engineers of the great radio compani of the world have been rapidly investigating the short wave transmissions and carrying on with high powers and on a larger scale the initial experimen It seems, therefore, undesirable that there should another bar to research in Great Britain in a field which the amateurs in particular have already do good work.

P. R. C.

The Biology of the Suez Canal.

THE Cambridge expedition for the investigation of the intermingling of the Mediterranean and Red Sea organisms in the Suez Canal left England last week in the Orient liner *Orcades*. The fauna of the Canal, which was opened in 1869, was first studied by Keller in 1882, a later reinvestigation of the fishes being made by Tillier in 1903. The organisms of the Red Sea and the Mediterranean are very different from one another, even though these two seas were connected by a narrow strait, approximately along the line of the Canal, in glacial times. The barrier to intermingling at that period would seem to have been fresh water, a considerable Nile mouth opening into the centre of the strait. In the time of the Pharaohs a navigable canal was dug, connecting a branch of the delta with the Gulf of Suez, which then extended about 30 miles farther north. By the time of Cleopatra this canal became impassable, owing to Nile silt, but it was afterwards reopened, being finally closed for strategic reasons by the Caliph Almansur towards the end of the eighth century. French investigations, carried out at Suez when Napoleon was in occupation of Egypt, showed certain Mediterranean jelly-fish, sea anemones, and other forms which did and do not extend to the south out of the gulf of the same name. These, if they passed by the Canal, must have been able to withstand the fresh water in its centre. The conditions then were the opposite to those of the present day, for t Bitter Lakes have now a salinity of about 77 gra per litre, or about twice the salinity of either of t terminal seas. These Lakes will be intensive studied, while the fauna of the brine pools in t deserts bordering on the Canal will also be examined

The Suez Canal Company is giving facilities respect to boats and by the use of its Canal Statio and it is hoped to carry the investigation to at lea two areas on either side of the Lakes. Each will intensively collected by trawl nets, dredges, a tow-nets of different sorts, while samples of t bottom and its contained fauna will be obtained means of the Petersen grab. Similar methods w be adopted at each place, so that comparisons will possible, not only as to the different species found each, but also to their relative numbers. The anima will probably be those which live in more or le moving sand, and special gear has been devised secure these. Then there are such swimming forn as fishes and a few crustaceans. Hard bottom for t attachment of sedentary organisms would only see to be present in a limited area in the Lakes, but the are piles and other artificial erections, and sunke vessels, in places; however, the larvæ of all a practically free living. The problems before t expedition are to ascertain what forms have passe through the Canal zone from the Mediterranean

the Red Sea and vice versa, when they passed through, whether in the prehistoric period, in the times of the earlier or of the present canal, how they passed through, whether by swimming, by drifting, by attachment to ships, or by other means. All these facts lead up to the question why some forms of life can get through the Canal and others cannot, and it is hoped that the expedition will throw light on marine migrations in general, the area being one which can be periodically investigated at small cost.

The expedition is in charge of Mr. H. M. Fox, Balfour Research Student of the University, who is responsible for the necessary physical, chemical, and physiological work. He is accompanied by Mr. Robert Gurney, who undertakes the plankton, and by two research students of the University. It has been arranged by a Cambridge committee, of which Sir Arthur Shipley is chairman, and is largely financed by the government grant administered by the Royal Society; collecting gear has been provided by the University and the Natural History Museum. It is a return to the former tradition that the Balfour student should undertake for part of his period of research an expedition to investigate some problem in the field.

J. STANLEY GARDINER.

University and Educational Intelligence.

DURHAM.—Applications are invited for a lectureship in geology at Armstrong College. The latest date for the receipt of applications (10 copies of each) is October 25. They should be addressed to the Registrar, Armstrong College, Newcastle-upon-Tyne.

LEEDS.—A programme has now been issued of the Celebration Week to be held on December 15-20 to commemorate the jubilee of the Yorkshire College of Science and the coming of age of the University. The ceremonies will include a number of receptions by local bodies, public lectures on the educational and architectural history of the University by Prof. A. J. Grant and Dr. A. Hamilton Thompson respectively, and on the aims of university education, by Sir Michael Sadler. A portrait is to be presented to Sir Michael Sadler in recognition of his manifold services to the University. Most of the ceremonies will be open to the public, and on the last day the whole University will be thrown open for inspection.

LONDON.—The University College Committee will shortly appoint a Quain student in biology. The value of the studentship is 150*l.* per annum, and it is tenable for three years. Applicants must have been already students of University College in the subject of botany. Full particulars can be obtained from the Secretary, University College.

Free public lectures will be given (in English) at 5.30 o'clock at King's College, on October 16 and 17, by Prof. H. Wieland, of the University of Freiburg, on, respectively, "Organic Radicals" and "The Theory of Oxidation Processes." No tickets will be required.

APPLICATIONS are invited by the Glamorgan Agricultural Committee for the position of Instructor in Agriculture under the Director of Agriculture. Candidates must be practical agriculturists, able to lecture and demonstrate in agriculture and allied subjects and to conduct field and live-stock experiments. Application forms (which must be returned not later than the morning of October 13) may be had from the Director of Agriculture, 5 Pembroke Terrace, Cardiff.

AT the meeting of the Scottish Universities Entrance Board held on September 27, Sir Richard Lodge, who was in the chair, alluded to the loss which the Board had sustained in the death of one of its members—Prof. Darroch. The following resolution was unanimously adopted, and it was agreed that a copy of it should be sent, with an expression of the Board's sympathy, to the late professor's daughter: "Prof. Darroch was an original member of the Scottish Universities Entrance Board as a representative of the University of Edinburgh. His unique knowledge of the educational system of Scotland, his shrewdness of judgment, and the careful thought and labour which he gave to the business of the Board, made him one of its ablest and most useful members. His colleagues desire to place upon record their appreciation of his services and their intense regret at the untimely end of a life which had been devoted to the cause of Scottish education."

AT the meeting of Convocation to be held on October 14, a chairman is to be elected to succeed the late Dr. R. M. Walmsley. There are two nominations for this important office, namely, Prof. S. L. Loney, whose mathematical books and activities in connexion with the work of the University are well known, and Sir Robert Blair, who was the Education Officer of the London County Council for twenty years. Sir Robert Blair has long been associated with the progress of science teaching in the schools. So far back as the British Association Meeting in 1910, he was pressing the claims of the technical and scientific expert for higher posts in industry and commerce: he has been a pioneer in technical education and has persistently advocated the need for training at universities and higher technical institutions. His knowledge and administrative experience should be of decided value to the University if he is elected chairman of Convocation.

THE "gifted pupil" in the high schools of Iowa forms the subject of a study, published in Bulletin, 1923, No. 46, of the Bureau of Education, Washington, by Charles Deich, professor of education, Simpson College, and Elmer E. Jones, director, School of Education, Northwestern University. That it is the duty of educational administrators to provide for the early identification of sub-normal children and the adaptation of their schooling to their special needs has long been recognised, but it is now coming to be realised that it is quite as important that supernormal children should not be retarded in their development through being made to conform to mediocrity. The Association of American Universities discussed in 1922 "The sifting out of the exceptional student and his relationship to the university curriculum"; the writers of the more recent Iowa report contend that too often irreparable mischief is done at an earlier stage: "If he is hampered by association with mediocrity, and if his course is not broadened and deepened to meet intellectual abilities and desires, he is doomed to a type of retardation that is wellnigh impossible to counteract in later educational work. No matter what his college life may be, or how excellent his graduate work, he has sustained a loss in his secondary training that can never be replaced." Accordingly, it is recommended that there should be in each year a survey of the schools undertaken in co-operation with university departments of education and psychology. By using the data thus obtained, teachers in the high schools would be able to identify the exceptionally gifted students with certainty by the beginning of their third high school year, and arrangements could be made for providing for them suitably enlarged and intensified courses.

Early Science at the Royal Society.

October 4, 1667. Mr. Charles Howard suggested, that it might be considered, whether maiz might not yield a kind of sugar, the stalks of it containing a very sweet juice; and he desiring, that he might be furnished with an account of the way of ordering the sugar-canes for the making of sugar, Mr. Oldenburg offered an account relating to Barbadoes.

October 5, 1661. Sir Robert Moray produced unnealed glass hollow balls with a small hole in them; which being held in the hand till they were heated (the hole thereof being stopped with the palm of the hand) would fly to pieces.—Dr. Goddard to try the velocity of sinking bladders in water, and the lord viscount Brouncker in air.—Dr. Ent to give in writing some considerations, why it is hotter in summer than in winter.

October 7, 1670. There was read a Latin letter from Signor Montanari, containing some new observations by him of the non-appearance of some stars of the second magnitude in the sky, though formerly observed by Bayer and others; and intimating that he had sent a manuscript, containing various experiments on the breaking of the glass drops, a task imposed on him by the grand duke of Tuscany.

October 8, 1662. Mr. Boyle was desired to shew, at the next meeting, the second part of his experiment about coagulation, viz., the reducing the coagulated liquors to their former fluidity.

October 9, 1661. A living chameleon was presented to the society from Mr. Clayton by Dr. Henshaw.—Dr. Croune, Dr. Pope and Mr. Rooke were appointed a committee to view the propositions for inquiries in foreign parts.—The lord viscount Brouncker read a letter of Dr. Christopher Wren to Sir Paul Neile, concerning his hypothesis of Saturn.

1673. The president gave the council notice, that there had been lately with him a committee of the professors of Gresham College, and another of the Mercers company, inviting the Royal Society to return to that college, and to keep their assemblies there, as formerly they did before the fire. To whom he had returned his thanks for this kind offer, and for their respect to the Royal Society. The council thought good to have their hearty thanks returned to the said committee for their kindness and respect, yet without saying anything to them of acceptance or not acceptance; only, in case they should give occasion for saying more, that then it might be mentioned, that the business was under consideration. The persons appointed to give these thanks were the lord viscount Stafford, Sir Paul Neile, Sir John Lowther, Mr. Pepys, Mr. Colwall, Dr. Croune and Mr. Oldenburg, or any three of them.—Whilst this was doing, Sir Theodore de Vaux came in, being sent by the earl of Norfolk, earl marshal, to acquaint the council, that his lordship wondered, that they were not met in Arundel-house, as formerly, but yet hoped, that they would hereafter still continue their meetings there, as formerly; and that if they should remove to any other place, he could not but take it very unkindly.—Hereupon the president declared, that for this time he had caused the council to be summoned in this place (his own house?) for his particular convenience, his present occasions not having permitted him to go far off. And his lordship, at the desire of the council returned their hearty thanks to the earl marshal for his singular affection and respect to the Society.

October 11, 1669. Ordered that Dr. Merret be desired to send the collection made by Thomas Willisel in his first voyage, to the society at their next meeting at Arundel-house.

Societies and Academies.

LONDON.

The Institute of Metals (Autumn Meeting), September 10.—D. M. **Fairlie** and G. B. **Brook** The determination of sodium in aluminium.—D. **Ingall**: The relationship between tensile strength temperature, and cold-work in some pure metals a single solid solutions. The critical inflection temperature is the all-important property of any metal alloy for high temperature service, as it would appe to be the temperature above which viscous flow ma take place and below which there is only stability the material in the cold-worked state. Other thing being equal, the higher the critical inflection temperature, the more suitable is the material.—H. **Moore** On the effect of progressive cold-rolling on the Brine hardness of copper. It has been stated that in th cold-rolling of copper, iron, tin and other metals ar alloys the Brinell hardness rises rapidly during th initial stages of deformation and then diminishe Experiments carried out at the Research Departmen Woolwich, give no support to the suggestion tha severe cold-rolling of copper beyond a certain stag induces softening.—F. W. **Rowe**: (1) Some exper ments on the effect of casting temperature and hea treatment on the physical properties of a high-t bronze. The bronze of the highest tin conte (copper, 86·0 : tin, 15·95 : phosphorus, 0·05) used in en gineering practice is employed for special bearing where low tin phosphor bronzes and leaded phosph bronzes have been found unsatisfactory. This allo attains its greatest hardness (and probably be wearing properties) with the lowest casting temper ture; this is, however, very often not practicab on account of the danger of "draws" in uneve sectioned castings.—(2) Some experiments on th influence of casting temperature and mass on th physical properties of Admiralty gun-metal. Admi alty gun-metal (copper, 88 : tin, 10 : zinc, 2) gives th best results in all sizes of bars with the lowest castin temperature, *i.e.* 1100° C., and the best tests of a with the ½ in. square bar cast at that temperature.—Tomojiro **Tanabe**: Studies in the aluminium-zin system.—T. H. **Turner** and W. E. **Ballard**: Meta spraying and sprayed metal. The process of metallisa tion invented shortly before the War and know generally as Schoop's metal spray process was hel back in its development by the unsettled conditio of industry, but is now being operated commercially The gas-operated metal spraying pistol now used i Great Britain and a rumbling barrel type of metallisin apparatus which is used for repetition work on sma articles were illustrated. All articles to be spraye are sandblasted and, in certain cases, preheating c the article to be coated is recommended, as this als tends to improve the adhesion. By spraying lightl on to glass slips it has been possible to examine th individual particles of the sprayed metals. Photo micrographs of these show that the metal must b molten at the instant it strikes the surface to b coated. Solid articles have been built up by sprayin and proved machineable and resonant. Practically any metal available in wire form and fusible in th oxy-hydrogen flame may be sprayed on to practicall any surface, *e.g.* on to paper, fabric, wood, or metal The surface produced is always matte, but may b polished if desired. The matte surface is an idea foundation for paints. Completed structures can b coated uniformly with any desired metal for pro tection against atmospheric corrosion, chemical attack or furnace conditions. The process has found a particular field in ship work, and is recommended fo the zincing of rail ends and fishplates for connectin purposes on electric railways.

Paris.

Academy of Sciences, September 1.—M. Guillaume Bigourdan in the chair.—MM. **d'Arsonval, Bordas,** and **Juplain**: Study of the waters of the glaciers of the Mont Blanc massif. The chemical and microscopical analyses of the sediments show that the Tour, Argentière, and Bois glaciers form one group: the Bossons Glacier shows peculiarities differentiating it from the others, on account of its intense mechanical effects on the underlying strata.—Henri **Jumelle**: Rodypsis, palm trees of Madagascar.—Maurice **Fschoud**: Calculation of the velocities for the steady state, by polynomials, in tubes with regular polygonal sections.—E. **Jouguet**: The speed of deflagrations. Development of results given in earlier communications, the hypothesis of a monomolecular chemical reaction being abandoned.—**Jarry-Desloges**: Contribution to the study of the planets Mars and Jupiter. Details of the changes observed in the appearance of the southern polar cap of Mars.—Ch. Ellissot: A simple arrangement for observing the optical disturbances in the atmosphere: application to the estimation of the definition of the images given by instruments. These disturbances are of interest in two directions, as limiting the accuracy of observations and as a means of supplying information concerning the movements of the atmosphere. A simple form of Fresnel's biprism is fixed to the objective of a small telescope and this is focussed on the objective of an astronomical telescope. Two half images are obtained, which may be either separated by a dark band, or partially superimposed, depending on the relative positions of the crest of the biprism and the focus of L. If the incident rays are free from disturbance, the exact position of the focus is sharply shown by the disappearance of the dark band. Optical discontinuities in the atmosphere are shown as striæ.—L. **Dunoyer** and P. **Thoulon**: Some electro-optical applications of arc relays. The principle of these relays has been described in an earlier communication (*Comptes rendus*, 1924, 148). Applications to optical signalling, directed optical radiotelephony, registration and reproduction of speech, television, and optical reception of radioelectric signals are described.—L. **Hackspill** and R. **Grandfam**: The saturated vapour pressures of mixtures of sodium and potassium chlorides.—H. **Gault** and C. **Truffault**: The chlorination of chloroform. The effects of light, temperature, and of various catalysts in the course of chlorination of chloroform was studied. Chlorination was prevented by the addition of ferric chloride to the chloroform, and this was shown to be due to the coloured solution absorbing the light rays determining chlorination.—David **Rotman-Roman**: The bostonites and camptonites of the Yemen.—M. E. **Denaeyer**: New observations on the geology of Tibesti - Djado - Kaouar.—Georges **Dubois**: Classification of the Quaternary of the north of France and comparison with the Danish Quaternary.—Mlle. Aimée **Camus**: New genera of Madagascan Bambusæ.—F. **Picard**: Observations on the solubility of the tannins and their extraction from plants.—Jean **Bathelier**: The development of *Euterpes matangensis*.—G. **Ramon**: The appearance of antibodies.

Melbourne.

Royal Society of Victoria, July 17.—Prof. Laby in the chair.—E. T. **Quayle**: Sun-spots and Australian rainfall. When the rainfall stations are arranged in climatic districts, both for the eastern and the western interior of the continent, the best rains occur during the "rising phase" of sun-spot activity and the poorest during the minimum phase. In the Northern Territory and Central Australia generally, the best rains occur later, or during the "declining phase," the lag amounting usually to 3 years, or in the case of Daly Waters possibly 4 years. The rainfall response to solar activity of the eastern and south coastal stations is generally so slight as to be almost negligible. For the rainfall increase over the eastern and western interior of the continent during the rising phase of solar activity, it is suggested that since these areas derive their rains almost entirely from air drifts of tropical origin, these must be of greater energy and frequency during this sun-spot phase. For coastal areas the maintenance of the rainfall during the minimum phase may be due to the greater frequency there of coastal cyclones. The increased rainfall in the Territory and Central Australia during the declining phase may be due to longitudinal changes in the loci of the southward tracks of tropical air drifts. The rainfall curves were smoothed by using 3-year means instead of the individual records, thus eliminating the effects of a possible 3-year period. The correlation coefficients of a number of these were computed. The correlations suggest that Bendigo and Daly Waters represent the maximum relations, both direct, but the former immediate and the latter delayed, and it may be that other stations show the double impulse in varying degree. With unsmoothed rainfall curves these two stations give lower correlation coefficients, +0·46 and +0·42 respectively, which suggests the probability of something like a 3-year period in their rainfalls. This is also suggested by breaking up the rainfall records into periods corresponding with those of the sun-spot cycles and taking the means of all the first, all the second, all the third (and so on) years of the cycle. For Bendigo there is for each the mean of six years. These results point to a tendency for droughts to occur every third year except during the rising period of sun-spot activity, which seems to have the effect of a forced oscillation.—J. A. **Smith**: On the graduation of circles. Reference was made to the work of Bird, Troughton, Ross, Ramsay and Swasey in the development of accurate methods of graduating circles.—G. F. **Hill**: Notes on *Mastotermes darwiniensis* Froggatt (Isoptera). After reference to the similarity of the ovipositor of the adult Mastotermes to that of the common American cockroach, the hitherto undescribed egg-mass of this termite is discussed. In all other termites, so far as is known, the eggs are extruded separately. Descriptions are given also of the third-form neoteinic king and queen and the first- and second-form nymphs. The seasonal appearance of the colonising flights and the distribution of this termite in tropical Australia are briefly discussed.—H. B. **Williamson**: Revision of the genus Pultenæa, Pt. iv. Two distinct forms have been included under *P. stypheliodes*, one with alternate and the other with ternate leaves. The former is the true *stypheliodes*; the latter is separated as *P. subternata*. *P. procumbens* is suggested as a low form of *P. stypheliodes* and made a variety of that species. Two new species, *P. trichophylla* from Port Lincoln, and *P. pubescens* from Mt. Gambier and the Grampians, are described.—F. **Chapman**: New or little-known fossils in the National Museum. Pt. xxviii. Some Silurian rugose corals. Four genera are here discussed. Lindstroemia is held to be a well-defined genus, with the genotype indicated by Nicholson and Etheridge's figured *L. columnaris*. Five species are recorded from Victoria, all of which are new. In the presence of a weak bilateral symmetry, some of the species show that the genus has some affinities with the Zaphrentidæ. Cyathophyllum is represented by two new species, from the

Yeringian—*C. cresswelli* and *C. subcæspitosum*, the latter closely resembling the Devonian *cæspitosum* of Devonshire and the Eifel and helping to strengthen the Devonian element in the Australian Silurian. In Spongophyllum there are two new species, one from the Yeringian of Victoria, *S. stevensi*, related to *S. sedgewicki*; the other, *S. shearsbii*, from the Yass beds of New South Wales. The genus Columnaria is represented by a new species from the Melbournian, *C. flemingtonensis*, preserved as a faithful negative mould in a fine ferruginous mudstone.—Miss Leslie Kerr: The lignotubers of Eucalypt seedlings. The lignotubers are embryonic storage organs, and not pathological as was previously supposed. These basal inflations of the stem attain their maximum development in the species inhabiting the most arid areas, while six species inhabiting regions of high rainfall do not develop them.

August 14.—Prof. T. H. Laby in the chair.—E. Kidson: Some periods in Australian weather. Recent work was described in extension of Dr. Braak's theories regarding a three-year period, especially clearly shown in the pressure variations at Port Darwin. Strong evidence of an 18-months cycle in the atmosphere, of opposite phase in eastern and western hemispheres, equivalent to a nutation of the whole circulation system, was adduced. Characteristic annual variations of the velocity, pressure, and latitude of anticyclones were evolved. A high correlation was established between the annual latitude range of anticyclones and sun-spot numbers.—E. J. Dunn: The centenary of Selwyn the geologist.

Official Publications Received.

British Museum (Natural History). British Birds: Summer Visitors. (Set C.11.) 5 cards in colour. British Birds: Winter Visitors. (Set C.12.) 5 cards in colour. (London: British Museum (Natural History).) 1*s.* each set.

The British Mycological Society Transactions. Edited by C. Rea and J. Ramsbottom. Vol. 9, Part 4, August. (London: Cambridge University Press.) 7*s.* 6*d.* net.

British Museum (Natural History). British Flowering Plants. Series 3. 5 cards in colour. (Set F.6.) British Flowering Plants. Series 4. 5 cards in colour. (Set F.7.) (London: British Museum (Natural History).) 1*s.* each set.

Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. Vol. 40, Fascicule 1: La détermination des plagioclases dans les coupes minces. Par L. Duparc et M. Reinhard. Pp. 149+13 planches. (Genève: Georg et Cie.) 20 francs.

The Physical Society of London. Proceedings, Vol. 36, Part 5, August 15. Pp. xxii+341-442. (London: Fleetway Press, Ltd.) 6*s.* net.

Decimal Metric Congress, London, July 9th, 1924. A Conference held for the Purpose of Considering the most effective Means of securing the adoption of Decimal Coinage and the Metric System. Pp. 48. (London: Decimal Association.)

Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne. (New Series.) Vol. 6, Part 1. Pp. 114+lxii. (London: Williams and Norgate.) 5*s.*

Department of Mines: Memoirs of the Geological Survey of New South Wales. Geology, No. 8, Supplement: The Geology of the Broken Hill District. By E. C. Andrews. Supplementary Note on the Geology of the Broken Hill District. Pp. 27+9 plates. (Sydney: Alfred J. Kent.) 21*s.*

Memoirs of the Geological Survey of India. Palaeontologia Indica. New Series, Vol. 7, Memoir No. 4: An Incomplete Skull of Dinotherium, with Notes on the Indian Forms. By the late Capt. R. W. Palmer. Pp. ii+14+3 plates. 1.2 rupees. New Series, Vol. 9, Memoir No. 1: On the Blake Collection of Ammonites from Kachh, India. By Dr. L. F. Spath. Pp. ii+29. 12 annas. (Calcutta: Geological Survey of India.)

Bureau of Education, India. Indian Education in 1922-23. Pp. iv+45. (Calcutta: Central Publication Branch.) 8 annas; 9*d.*

Proceedings of the Royal Society of Edinburgh, Session 1923-1924. Vol. 44, Part 2, No. 16: On Mixed Determinants. By R. Vaidyanathaswamy. Pp. 168-184. 1*s.* 6*d.* Vol. 44, Part 2, No. 17: The Ultra-Violet Emission Spectra of the Halogens. By Dr. E. B. Ludlam and W. West. Pp. 185-196. 1*s.* Vol. 44, Part 2, No. 18: The Budde Effect in Bromine. By Dr. E. B. Ludlam. Pp. 197-201. 9*d.* Vol. 44, Part 2, No. 19: Apparatus to facilitate the Use of an Oxygen-Carbon Dioxide Mixture in the Treatment of Carbon Monoxide Poisoning. By Prof. Henry Briggs. Pp. 202-205. 9*d.* (Edinburgh: R. Grant and Son; London: Williams and Norgate.)

University of Liverpool Tidal Institute. Fifth Annual Report, 1924. Pp. 8. (Liverpool.)

Proceedings of the Geologists' Association. Edited by G. M. Davies. Vol. 35, Part 3, August 25th. Pp. 169-264. (London: E. Stanford, Ltd.) 5*s.*

The Memoirs of the Imperial Marine Observatory, Kobe, Japan. Vol. 1, No. 4, August. Pp. vi+137-239+49+46 plates (Kobe.)

Union of South Africa: Department of Agriculture. Science Bu No. 34: Kemp Fibres in the Merino Sheep. By Prof. J. E. Duerde Miss M. Ritchie. Pp. ii+18. (Cape Town.) 3*d.*

Prospectus of the Royal College of Art, S. Kensington, London. S 1924-1925. Pp. iv+28. (London: H.M. Stationery Office.) 6*d.* ne

Department of Scientific and Industrial Research. Summary o gress of the Geological Survey of Great Britain and the Museu Practical Geology for the Year 1923; with Report of the Geological S Board and Report of the Director. Pp. iv+173. (London: Stationery Office.) 4*s.* net.

The University of Birmingham: Faculty of Science. Careers to Subjects may lead and other Information. Pp. 31. (Birmingham.)

Collective Index of the Journal of the Institute of Brewing, 1911 to Compiled by W. H. Bird. Pp. iv+330. (London: Harrison and Ltd.)

Imperial Department of Agriculture for the West Indies. Repo the Agricultural Department, Grenada, January-December 1923. I +14. (Grenada: Government Printing Office.) 6*d.*

Merchant Venturers' Technical College. Calendar for the Sixty- Session, 1924-25. Pp. 55+17 plates. (Bristol.) 6*d.*

Diary of Societies.

MONDAY, OCTOBER 6.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—E. Ki Scott: Pulverised Fuel.

INSTITUTE OF TRANSPORT (at Institution of Electrical Engineer 5.30.—Sir Lynden Macassey: Presidential Address.

TUESDAY, OCTOBER 7.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Art 5.30.—Dr. A. E. Dunstan: Recent Development in the Art of Crac

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—E. B. C The Glory of the Garden.

WEDNESDAY, OCTOBER 8.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (at 11 Chandos Street, at 5.—Dr. R. Hutchison and others: Discussion on The Relative V of Stone-milled and other Flours and Breads in relation to the Nutr of the Growing Child.

NEWCOMEN SOCIETY (at Iron and Steel Institute), at 5.30.— Jenkins: A Sketch of the Industrial History of the Coalbrook District.—T. S. Ashton: The Discoveries of the Darbys of Coalb dale.—J. W. Hall: Notes on Coalbrookdale and the Darbys.

THURSDAY, OCTOBER 9.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at W gate House, Adelphi), at 7.30.

OPTICAL SOCIETY, at 7.30.—E. T. Hanson: Some Problems in the Th of Optical Diffraction.—W. M. Hampton: (*a*) The Annealing of G (*b*) The Re-annealing of Glass.

FRIDAY, OCTOBER 10.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. D. Johns Wonderlands of the Western Worlds.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—N. Thornton: The Desi Static Sub-stations, with some notes on their Equipment.

SATURDAY, OCTOBER 11.

BRITISH PSYCHOLOGICAL SOCIETY (at University College), at 3.— C. Spearman: The New Psychology of "Shape" (Gestalt).—S. Hamid: Some Factors of Effectiveness in Mental ("Intelligen Tests.

PUBLIC LECTURES.

MONDAY, OCTOBER 6.

KING'S COLLEGE, at 5.30.—Prof. E. W. Scripture: What the Voice l like.—Rev. Dr. F. A. P. Aveling: Introduction to Psychol (Succeeding Lectures on October 13, 20, 27.)

TUESDAY, OCTOBER 7.

UNIVERSITY COLLEGE, at 5.—Prof. G. Dawes Hicks: Philosophy Psychology.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Philosoph Bergson: Its Relation to Past Systems and to Present Scie (Succeeding Lectures on October 14, 21, 28, November 4, 11.)

WEDNESDAY, OCTOBER 8.

KING'S COLLEGE, at 4.30.—Dr. C. da Fano: The Histology of the Nerv System. (Succeeding Lectures on October 15, 22, 29, November 5 19, 26.)—At 5.30.—Prof. R. J. S. McDowall: The Human Body and Function. (Succeeding Lectures on October 15, 22, 29, November 5

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Miss Hosgood: East Australia—Some Problems in Human Geography.

UNIVERSITY COLLEGE, at 6.—Prof. C. Spearman: The Current View Individual Differences in Ability.—At 7.—A. H. Barker: The Hea Equipment of a Large Country House.

FRIDAY, OCTOBER 10.

UNIVERSITY COLLEGE, at 5.—Prof. Borenius: History and Art: Pain in the Netherlands and Spain.—At 5.30.—Prof. S. L. Rashkovit Water Supply and its Purification. (Succeeding Lectures on Octo 17, 24, 31.)

NATURE

SATURDAY, OCTOBER 11, 1924.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON

The Abrams' Cult in Medicine.

IN our issue of June 7 we published an article on "the Abrams' Cult in Medicine" and indicated that the claims made on behalf of the late Dr. Abrams were without scientific foundation. One of the many ridiculous diagnoses made by means of the so-called electronic dynamiser was quoted, and the methods employed by the "electronic reaction Abrams" (E.R.A.) were described. In the July, August, and September numbers of the *Scientific American* there is an extensive report of a committee of experts appointed by that journal to inquire into the actual facts of the case. The committee consisted of thoroughly trained medical and electrical investigators, including such well-known men as W. H. Park, W. C. Alvarez, R. C. Post, and J. M. Bird, with A. C. Lescarboura as secretary. These men have spent a year chasing the elusive methods of electronic medicine. They have interviewed and co-operated with electronic practitioners and experts in the new cult, and the result is disastrous to the reputation of Albert Abrams.

The report of this committee is in what may be described without offence as the characteristic American style—interesting to those on the eastern side of the Atlantic. The authors of the report state that the "Electronic Reactions of Abrams are not substantiated, and it is our belief that they have no basis in fact. In our opinion the so-called electronic reactions do not occur, and the so-called electronic treatments are without value." In another place the committee states that "the entire Abrams' electronic technique is not worthy of serious attention in any of its numerous variations. At best it is an illusion. At worst it is a colossal fraud."

The *Scientific American* committee gives a clear account of the genesis of the Abrams' myth, and shows how the Californian Cagliostro's claim that the basis of life is bound up with the movements of electrons is a question which does not admit of proof. On the electronic basis, however, Abrams invented a mysterious box called a dynamiser for collecting the electronic emanations, and elaborated a portentous system in which diagnoses of the most obscure ills of life were said to be possible, at a distance of thousands of miles, from the emanations given off by a drop of blood on a disc of blotting-paper. Not only the disease of the patient but also the height, habitus, colour, sex, and religion were said to be capable of revelation by the dynamiser—a childish toy which defies all the laws of electrical science. In one of Abrams' own demonstrations he placed in the dynamiser a photograph of a man and foretold his disease as insanity due to syphilis, and on running the electrode across a map of America

it stuck at Stockton, California, which was consequently proclaimed as the patient's address!

By judicious advertisements and newspaper "puffs" by credulous persons and those in quest of sensational material for the press, Abrams' claim to diagnose disease at a distance was soon noised abroad, and Abrams founded a school rich in financial possibilities. He then added to the diagnostic scheme one of electronic treatment, thus providing a wider field for commercial exploitation. New companies sprang up to manufacture the Abrams' dynamisers and oscilloclasts at fancy prices. Schools for training Abrams' practitioners were founded, and a motley array of medical men, osteopaths, chiropractors, and electro-naturopaths hied them to sunny California to sit at the feet of Gamaliel and hear him expound the new science. Within a few years, more than three thousand practitioners of electronism were trained for their life work in the United States alone. They found that there was a rich harvest in dollars, in comparison with which ordinary medical practice was a poor profession.

When one reflects that we are living in the twentieth century, and that both medical and lay people can believe something which has no meaning, it is clear that there is no limit to credulity. There have been great humorists in history, but Dr. Albert Abrams of California must surely head the list. To invent a new form of energy which cannot be tested by any known method except by the five senses of Abrams and his pupils is something of an achievement. To determine the sex of a child *in utero* from a drop of the blood of the father a thousand miles away is asking one to believe a good deal. To explain errors in electronic diagnosis in California by wireless disturbances on the Eiffel tower in Paris or activities on the planet Mars is perhaps reasonable from the electronist's point of view. To expect, however, your fellow-creatures to believe all this nonsense, and to earn vast sums of money by the delusion, may be classed as a form of humour to which our psychologists and mental philosophers have not paid due attention. Although the *Scientific American* committee has exposed the absurdity of Abrams' system, it does not follow that its labours will be crowned with a universal success, for in all probability there will still remain hundreds of genial persons who do not mind paying their dollars to hear the joyous tick-tack of Abrams' oscillating metronome.

We live in an age of science, but it is as easy now as ever it was for the charlatan to impose on the credulity of the public. The penalty of great scientific achievement seems to be that people are ready to accept the most astounding claims, provided they are put forward in the name of science. W. B.

Science and the British Empire.

The Resources of the Empire Series. Vol. 1, Pa
Crops and Fruits. By J. R. Ainsworth-Davis. Pp.
144. Vol. 1, Part 2: *Meat, Fish, and Dairy*
duce. By J. R. Ainsworth-Davis. Pp. 104.
2: *Timber and Timber Products: including*
Making Materials. Edited by S. J. Duly. Pp.
Vol. 3: *Textile Fibres and Yarns.* By J. S. M. W
Pp. 192. Vol. 5: *Rubber, Tea, and Cacao;*
Special Sections on Coffee, Spices, and Tobacco.
piled and edited by W. A. Maclaren. Pp. 334.
6: *Leather, Hides, Skins, and Tanning Mate*
By Dr. E. C. Snow. Pp. 368. (London: E
Benn, Ltd., 1924.) 21*s.* net each vol.

EVEN in these days, people still occasionally to science, or at least to natural science, as subject of purely academic interest, though remark changes have been made during the last thirty y In the lifetime of the present writer it has bee interest to watch the gradual penetration of the met of the natural sciences into many branches of knowle Many subjects, formerly holding themselves mor less aloof, are now permeated by scientific method, work upon lines as scientific (or knowledge-making that is what the word implies) as are those of su science as botany, at any rate, even if not yet of s a science as physics.

The world is, indeed, gradually realising that scie simply means organised and reasoned knowle without which rapid progress is almost impossi Knowledge is good, and organisation is good, and their combination there are opened up possibilitie progress to which we can see no limit. Both kn ledge and organisation are necessary for satisfact and efficient work, yet the combination of the two long looked at askance, probably because it was f applied to subjects that seemed to have little or bearing upon practical life. With the proper org isation of inductive knowledge, general laws of e wider application begin to appear, progress becom more and more rapid as deduction becomes more a more possible.

Such being the case, it is a little difficult to draw line in referring to developments in the British Emp due to science, for which the volumes in question serving as the text. Engineering, the most import of all as yet, must, of course, be considered, and also rapidly growing science of agriculture, which is strong basis of the art of agricultural practice.

Scattered over the four quarters of the globe as it the British Empire has an enormous variety of sources, and there are few things required by mod civilisation which it cannot if needful produce.

st necessity, however, is security of life and of perty, and this scattering of the parts makes the mire more vulnerable, necessitating the keeping up great fleet, in which the application of science nifest in almost every detail.

he second great necessity is an adequate popula- for the various parts of the Empire, and this presents haps the most difficult problem that lies before our smen at the moment; for there is no doubt that ept in the British Isles, in India, and a few West an islands, the population is absurdly inadequate. ralia and Canada with their enormous areas have, n rather less, the other rather more, than two ple per square mile, against 7 in Argentina and Brazil, to take countries of similar sizes and ages. portant though this problem is, however, scientific wledge of the many questions involved is as yet n in the early stages of organisation, and one can cely draw deductions upon which it is safe to act. ence is rapidly entering very largely into the stion, however, with the wonderful discoveries of last half-century in medicine, bacteriology, surgery, t, discoveries which have saved great numbers of s, and have much improved efficiency.

s the population grows, so also must the food-supply, the present condition of that of the Empire affords interesting study. At the headquarters of Empire re is no pretence at growing enough food for the ple—the fact that the British Isles are admirably ated and equipped by Nature for a manufacturing ntry, added to the ordinary laws of supply and nand, have ordained that the population shall out- w the local food-supply, and live largely by export de, obtaining food in exchange. In this exchange, countries of Europe, and the United States, with ir large populations causing a large demand for nufactured goods, and with their nearness to the itish market, have an advantage over most of the Inpire countries, though Canada and others with reasing population are steadily taking an increasing are in the supply of the comparatively non-perishable d-stuffs such as wheat, or of those that can be sent cold storage. The general tendency at the present ne seems to be in this direction, with increased tention at home to the more perishable supplies food, at present largely imported from the ntinent.

The other Empire countries usually grow enough od for their own people, though some, like Ceylon, e strange exceptions, and they have often a fair nount left over for export to Europe or to whatever arket is most suitable and profitable. When the arket is very attractive, as, for example, the British arket in wheat, they tend naturally to make a special business of growing for it. Parts I. and II. of the first of the volumes under consideration, from the able pen of Prof. Ainsworth-Davis, deal with the food of the Empire, with full statistics of production, trade, etc., and place before the reader an organised mass of detailed information upon the subject, from which, by aid of the further necessary equipment of a scientific mind, it is possible to deduce promising lines upon which to act. What at present seems to be chiefly required is the more complete application of science to agriculture, to ensure a greater, more profitable, and more economic yield of the food crops. This is especially needful in Britain itself, in order that the country should produce more food, and thus be more secure in the event of another great war, though it seems unlikely that the country will ever be able to dispense with import upon a large scale, even of the first elements of food, which is all that we are at present considering. In the rest of the Empire, work of this kind is just as useful, inasmuch as it may diminish cost of production of necessities, and thus set free more labour for leisure and luxury.

Now this in fact is what is actually happening all over the world. By the study of pests and diseases, for example, science has rendered, and is rendering, great service to those who suffer from them, and by checking their ravages is thus increasing the yield and profitableness of both plant and animal husbandry. By a proper chemical study, the art of cheap and efficient manuring has become much better understood, thus providing greater increases of yield at less cost than formerly. Similar results have been obtained by the proper study of the feeding of animals. The rise of Mendelism in recent years has enabled us at any rate to make a commencement in the direction of breeding upon scientific lines towards a desired end, instead of merely taking "the gifts the gods provide." Already results are being obtained, for example, with Prof. Biffen's new wheats, that may lead to great developments in the near future. Fruit and vegetable growing, and all other forms of agriculture and horticulture, are similarly receiving close attention at the hands of properly trained men, as are the fisheries and the study of domestic animals.

In the Dominions, on the other hand (as in the United States), the scarcity of labour has tended to make the scientific development of labour-saving one of the most important directions of research, whilst the impossibility of carrying many food-stuffs to Europe in their natural fresh condition has stimulated research into methods of canning and of cold storage, both of them lines in which much work is now being done, and considerable trade springing up.

Not only must the people be fed, but they must in

general be clothed also, to at least the minimum degree prescribed by local custom; and in this connexion the volume upon fibres (Vol. 3) comes in useful. By far the most important fibres for clothing are cotton and wool, and of the latter the Empire produces a very large proportion of the world's supply. On the other hand, the position in regard to cotton is not one in which to sit with folded hands. Of short-stapled cotton the Empire produces the bulk of the world's supply, in India, and with it clothes a great part of the population of that country, besides exporting much to Japan and elsewhere. But of the cotton of medium and long staple, such as is used in Lancashire, the Empire produces less than 200,000 bales, against a world consumption of about 15 or 16 millions, when it ought to produce about 25-30 times as much, and with the falling-off in the supply from the United States, bids fair to get into difficulty.

This position has long been foreseen, and the British Cotton Growing Association was formed more than twenty years ago to deal with the question, but of late there has been added to this body, which has done a very great amount of valuable pioneering work under great difficulty, the powerful Empire Cotton Growing Corporation, which, though not directly a department of Government, but managed chiefly by far-seeing and capable Lancashire business men, received Government aid in an endowment, and in a compulsory cess upon all cotton used in Great Britain. Nothing could show more clearly the strong position that science now holds than does the work of this Corporation, which supports financially the work in many scientific institutions, trains its future workers in science laboratories in England and elsewhere, and in general acts upon what may rightly be called scientific lines.

So old and so long established are the weaving industries, and so entirely do they depend upon mechanical methods, that as yet there has been comparatively little intrusion of scientific methods into them other than in the constant improvement of the machinery.

Leather, upon which there is a volume (Vol. 6), may also be mentioned here, inasmuch as shoes (or sandals) have ceased to be a luxury, and have become a necessity to a great many. The large size of the volume just mentioned, compared with the small size of that dealing with the food-stuffs, prompts the reflection that the work is somewhat unevenly proportioned; the volume dealing with tea, cacao, coffee, and rubber is almost equally large. To return to leather, since the Empire contains about 40 per cent. of the animals which furnish it, there is no reason to fear any shortage.

The people must also be housed, and in this connexion the volume upon timbers (Vol. 2) is useful as indica the resources of the Empire in one of the prin materials used in housing and furnishing. In mos the tropical colonies, and in India, the housing is sin of type varying with the materials that are most rea obtainable locally, for example, bamboo in Mal mud-and-wattle in Ceylon (with a tendency to repl ment by kerosine tins), and the like. But in the w portions of the Empire, with their colder clim housing has become more standardised, and perhaps since the War is there any tendency to a long-established custom, or to invoke the aid scientific knowledge in building.

We may take it then that as the Empire incre in population it will be able to feed, clothe, and h the people without any falling-off from the pre standards, the necessary corollary being fulfilled adequate and economical transport be provided to up its different parts, some of which will provide item, some another.

A country in which the people are merely clothed, and housed, upon the lowest terms (so speak), cannot, however, be called rich, prosperous progressive. The possession of riches implies the po of obtaining the best of everything in the grea variety, and the possession of sufficient leisure education to enjoy travel, art, music, literature, the other adornments of life. The possession of wea that goes beyond this confers little upon its owner power, and it should chiefly be used as investme There is therefore something to be said for the grad diversion of such wealth to the use of the State a basis for the improvement of the position of alike. It must not, of course, be supposed that ma people possess, or are likely in the near future possess, riches enough to command all that has be indicated, but most people strive to obtain as much possible, some in one direction, some in another; a tastes differ.

For this amelioration of the conditions of life, whi has long been going on, and will, it may be hoped, lo continue, many things are necessary, not the lea among which is an extensive exchange of produc between one country and another, involving cheap a good transport. Life would be a poorer thing Britain had we no sugar or spice, no rice, sago, tapioca, no tea, coffee, or cocoa, no rubber, no wi or tobacco, no oil (whether mineral or vegetable), wi its concomitant no soap, no cotton or jute, no go or silver, no bananas, oranges (marmalade), grape currants, raisins, or many other things, to say nothi of our import of many of the basal necessities of li The great dominions and the smaller colonies a equally deficient in many things needful to make l

fortable as judged by our present standards, and ...out the present extensive trade that goes on, life ...ld soon be reduced to very simple terms once more. ...nsport, upon its present efficient lines, has only ... rendered possible by the work of engineering ...nce, and improvement continues to be made almost ...y.

Whilst there is scarcely any country in the world now ...rovided with the comparatively cheap steamship ...nsport, the development of land transport still ...es much to be desired. It goes, as does the former, ...h the development of sufficient trade to make it ... its way, or roughly with the growth of population, ...ugh a tendency is now becoming clearly marked for ...ds and railways to be made in advance, to encourage ...l growth of population, agriculture, and trade. Air ...nsport, which may at any time become of enormous ...portance, need only be mentioned here. An im...tant concomitant of transport is rapidity and ease ...communication. At first dependent directly upon ...former, it has now become to a considerable extent ...ependent of it, as witness the wonderful feats of ...ence in the invention of the telegraph and the tele...one, at first with wires, and now without, the in...tion of "wireless" promising to revolutionise ...world in this direction at some not very distant ...e.

In the provision of what we may term the luxuries, ...t make life more enjoyable, and that give a real and ...gible value to monetary wealth—luxuries that one ... one come to be regarded as necessities—science has ...d a very large and increasing share, which may be ...efly indicated. But it must be realised that all parts ...the question hang together, and that progress in one ...n only accompany progress in another. Progress in ...neral is slow, but every now and then some great ...nius appears, whose invention or discovery involves ...ange in many departments of life.

Agriculture (in the broadest sense), and mining, ...ovide the great bulk of the raw material of wealth, ...t transport, and more or less of manufacture, are ...nerally needed to make it really available for use. ... early days agriculture was (of necessity) conducted ...ainly upon the principle of "grow-what-you-want-...d-consume-what-you-grow." Gradually, with the ...provement of transport systems, a certain amount of ...ecialisation came in, whilst a considerable trade ...rang up in the products of wild trees or plants, which ...uld be collected without cultivation, and were worth ...hile, such as rubber, gutta, cinchona, cinnamon, and ...any other things.

While at first the products of any country were such ... were native to it, this gradually altered with the ...provement of transport, and the useful plants and animals of one part of the world were carried to others, at first often to places quite unsuited to them. Thus, at the present time plants are cultivated for market quite irrespective of their countries of origin, though in a few instances, such as cinnamon in Ceylon, the original country has retained a practical monopoly. Even up to quite recent times there have been striking examples of the success of introduced cultivations in new countries, as witness the rubber boom of a few years ago, and the present extension of cotton in tropical Africa. But this phase must necessarily pass, inasmuch as everything will soon have been introduced into all the countries where it will be likely to succeed. At the same time, the great extensions of cultivation thus brought about have often reduced the profitableness of a cultivation to a very low point. On both counts the aid of science is now being called in, and the next phase of agriculture will be the scientific. It is almost needless to say that science has always had more or less to do with agriculture, for example, by means of the Botanic Gardens maintained in many places; but there is no doubt that its share in agriculture is increasing all the time, so that cultivation may be said to be becoming more and more scientific, both in itself and in its accessories, such as disease-prevention and the like.

While the necessary elements of food have been practically always available in ample quantity, luxury in food continues to increase, and many things once regarded as luxuries are now usually counted as necessities, such, for example, as tea, coffee, cocoa, spices, and tobacco (to call this a food for the moment), to which Vol. 5 is devoted. Improvement in food is due to many things, but chiefly to greater variety of origin (with which of necessity goes the transport to carry it to other places), and to improvement in the actual kinds of animals or plants used. In both of these, but more especially in the latter (by improved breeding), science has had a large share, and will probably have a larger share as time goes on.

Fibres in the same way are being provided from an increasing number of sources, and their uses are being extended, while at the same time, by the application of science to cultivation and treatment, the yield is being increased, and the quality improved. The great need before the Empire at the moment is to increase the production of good cotton within its boundaries.

New timbers, too, are being discovered, and new uses for timber, but there is still much room for the application of scientific method. If some way of exploiting the mixed forest of the tropics could be discovered, which would place at the disposal of mankind its great riches in many valuable timbers and other products, a great service to humanity would be done.

P I

To the achievements of science in adding new amenities to life one cannot refer in detail; let it suffice to direct attention to such things as the telegraph and the telephone, to rapid and comfortable travel by steamboat, by rail, by road, by the motor and the aeroplane, to wireless communication (including listening-in), and to innumerable other inventions, only rendered possible by scientific discovery and its application.

The problem now, and probably always, before us, is to increase the supply of the luxuries of life, and make them more available to every one, while at the same time cheapening the cost of production of the necessities and setting free more labour to be devoted to the former. At the same time, for a long while to come, we must allow for a continually increasing population. There are obviously many factors that come into this problem, including, for example, increased efficiency—best brought about perhaps by the careful application of statistical and other science to the problem in hand and by better education—and greater and more economical application of power derived from coal, from oil, from water, and from other sources as yet untapped, and only to be tapped by the careful application of science; and many other factors which determine human progress.

For such work as now outlined, haphazard methods are of little or no use; we require our knowledge systematised and organised to the highest degree possible at the moment. It is for this reason that one welcomes the publication of such volumes as those under consideration, appearing at the same time as the great exhibition at Wembley, which lay before us a clear picture of the actual resources of the Empire, so far as they are at present known. That many more remain to be discovered by the aid of scientific research need scarcely be said of course, though one must in passing note the interesting fact that in agriculture, at any rate, the knowledge and skill of the white man has added comparatively few products, and none of first-rate importance, to those which were known in prehistoric days. Economic botany, which requires its main assistance from organic chemistry, is as yet too much of a chaos of facts, with few general laws that we can yet see that underlie them, to be of any use in making predictions. This, however, will doubtless be altered in time, and with the wonderful improvements in breeding that are taking place as a result of Mendel's work, we may look forward to the future breeding of economic plants "to order." The heyday of empirical practice has passed, and the future appears to lie with scientific (or organised and classified) knowledge. It is for statesmen to see that the power which this knowledge gives is used for the well-being of mankind.

Rejuvenation.

Rejuvenation and the Prolongation of Human Efficiency: Experiences with the Steinach-Operation on Man and Animals. By Dr. Paul Kammerer. Pp. 25 (London: Methuen and Co., Ltd., 1924.) 8*s.* 6*d.* ne

WHEN a new development in science has pr vided the low comedian with material for je and the popular author with a plot, when from t biassed misinterpretation of the journalist it appea that a discovery has been made that must revolutioni the life of the individual and of the community,—th it is high time that some one with a training in th particular branch of science and in scientific metho and with a literary ability that enables him to interpr to the man-in-the-train, should give a popular presen ation of the facts and the theories based upon then so that all those who seriously seek information on th subject can glean it. A book in English dealing wit the operative methods of achieving rejuvenation an giving in a legitimately popular form a critical revie of the work of Steinach, Voronoff, and their followe has, therefore, been expected for some time; and th is attempted in the volume before us.

The interested general public wants to know curre biological opinion concerning the cause of ageing an death; it wishes to learn whether and how one ca be compensated and the other postponed. Is agein the result of the accumulation of the effects of aut intoxication, of inefficient excretion of the deleterio end-products of metabolism? Is one of the function of the glands of internal secretion to purify and vitalis the whole body; and are these glands so inte dependent that if one comes to function less efficientl the whole endocrine system is thrown out of gear Can the adequate functioning of the endocrine syste in these circumstances be re-established by operativ measures that repair the weak link in the endocrin chain? It is on the assumption that the answer t all these questions is in the affirmative that rejuvena tion has been attempted deliberately by injection o extracts, by the implantation of glandular tissue, an by the ligation of the deferent duct of the testis in th male.

It is claimed that specific and demonstrably bene ficial results follow such treatment in the huma subject, in farm stock, and in the laboratory mammal It is desirable that this claim should be examined mos carefully, particularly in the case of the human, fo here it is always necessary to allow for the effects o suggestion. There is plenty of evidence available fo this examination, and of such a kind as to lead to th conclusion that it is possible in suitable cases to achiev rejuvenation.

s for the methods to be employed, that of injection uch extracts as are available at present is utterly rustworthy; for the implantation of grafts an adete supply of human or simian gonad is required, this is not easily maintained; unilateral ligation he deferent duct of the male, on the other hand, is imple operation that has often been performed, ugh Steinach was the first to do so for the dee purpose of bringing about the rejuvenation cts.

f the Steinach operation is followed by demonstrable provement in the general well-being of the individual, l there is considerable evidence which seems to show it it is, then this operative procedure must quickly l its way into human and veterinary surgery. For mple, it would mean much to the stock-breeder to able to get another year's crop of offspring from a ous sire.

Rejuvenation in the female is an altogether different tter. Not nearly so much work has been done in s field. The most promising method would seem be that of irradiation of the ovaries with X-rays; s leads to sterility, but at the same time, it is claimed, rejuvenation.

The whole question is being followed with the greate interest by the medical man who has to prepare nself for the giving of advice, and by the patient who inclined to seek it. For the former there are the dical journals; for the latter there are the newspers, and now we have Dr. Paul Kammerer's survey the subject.

Reading this book, one gains the impression that it a literal translation of a German manuscript into an nericanised English by one who is not a physiologist. is full of phrases that startle and hurt both the man science and the grammarian, and about it there is too much that savours of advertisement. It is true at the facts concerning the methods and the results the operative treatment of old age will be found in e book, but far too frequently they are completely scured by a painful misuse of the English language, a lack of knowledge of the author's meaning, and norance of physiological terminology on the part of e translator.

The book suffers also, and severely, from the o strenuous effects that were made to present e subject in a popular form: there is a degree of opularity offensive to the professional scientific orker, who cherishes the dignity of his science. The bject is a most fascinating one, for throughout the ges man has yearned for immortality and has ever hemed to achieve it. A most excellent popular book ould be written about it: in our opinion, it still emains to be written. F. A. E. CREW.

Our Bookshelf.

Time Measurement: an Introduction to Means and Ways of Reckoning Physical and Civil Time. By L. Bolton. (Bell's Natural Science Series.) Pp. viii+166+8 plates. (London: G. Bell and Sons, Ltd., 1924.) 6s. net.

IN this book the author has aimed at giving the rudiments of time measurement to readers possessing no previous knowledge of the subject. The first forty pages deal with the nature of time measurement and of the more prominent natural cycles (the year, the day) suitable for the purpose of measuring time. To assist the reader towards an exact understanding of the astronomical terms involved, the author insists upon the use of the globes and the armillary sphere, and describes in full detail a cheap home-made example of the latter instrument.

Early time-pieces (water clocks, sand clocks, and sundials) for subdivision of the day by artificial means are next briefly described. This is followed by a chapter on weight-driven clocks of the thirteenth and fourteenth century, descriptions being given of De Vic's clock (*c.* 1370), the Wells clock (*c.* 1393), and the Dover Castle clock. Photographs are shown of the two latter examples, which have for many years been exhibited in going order in the Science Museum at South Kensington. The author directs attention particularly to this chapter and a later one dealing with striking mechanisms, pointing out that though of rough workmanship, these early machines were anything but crude in conception, and expressing the hope that "the reader who studies these chapters will be left with an enhanced respect for the attainments of the Middle Ages."

Other chapters deal with the work of Galileo and Huygens; Hooke, Graham, and Harrison; driving mechanisms; watches and chronometers; electric clocks; Greenwich mean time; the calendar. Though the few short biographical notes woven into the text in some cases throw unduly into relief certain personal imperfections (Hooke—"unlovely character," "unhappy miser," "stinginess"; the two Scaligers—"not entirely reliable in personal matters, and altogether they seem to have been unpleasant people to deal with"), the book as a whole deserves commendation as a good introduction to its subject, especially for the class of reader for which it is intended.

Sunshine and the Dry Fly. By J. W. Dunne. Pp. v+136. (London: A. and C. Black, Ltd., 1924.) 5s. net.

MR. DUNNE'S book will be read with great interest by the devotees of dry-fly fishing, if only for its unorthodoxy, amounting almost to heresy, in its attitude to the works of Halford, hitherto regarded as the standard works on the art of dry-fly making, and slavishly used by most anglers. The author objects that Halford obtained the colours of his dry flies from the natural flies seen under wrong conditions of light, and that his record of colour is therefore erroneous. Mr. Halford placed the natural flies on their dorsal surfaces in a white saucer and allowed strong light to fall on their ventral surfaces, and in this way sought to obtain the colours of the fly as seen by the fish. As Mr. Dunne

points out, this method reduced the light showing through from the back of the fly and increased that reflected from the ventral surface, with the result that Halford's colours are darker than they should be. Further errors crept in from the use of preserving fluids, which materially altered the colour of the natural flies preserved in them for copying purposes.

Mr. Dunne seeks to remedy these two sources of error. He avoids the use of preservatives for his models, and studies their colour by placing them on a glass plate in their natural position, dorsal surface uppermost, and examining them from below against the sky, thereby reproducing more closely the conditions under which the fish sees them. From this point of view the author has reviewed Halford's work and produced a new series of dry-fly patterns, full directions for the tying of which are given in a valuable appendix. He has also experimented with the view of imitating more closely the translucence of the natural models, and claims to have succeeded even beyond his hopes. Mr. Dunne's book is vigorous and stimulating, and deserves careful study by his fellow-sportsmen.

A Dictionary of Applied Chemistry. By Sir Edward Thorpe; assisted by Eminent Contributors. Revised and enlarged edition. Vol. 5: Oxygen to Rye. Pp. viii+722. (London: Longmans, Green and Co., 1924.) 60*s.* net.

THE fifth volume of the new edition of Thorpe's "Dictionary of Applied Chemistry" has recently been issued, covering the section from Oxygen to Rye. This section has been enlarged from 570 to 722 pages. The most important additions are a new article on "Electrical Precipitation" by Dr. H. J. Bush, covering 17 pages and containing 20 figures, and a new article on "Refractories" by Dr. J. W. Mellor, which covers 10 pages and contains 6 figures. The article on paints has been expanded, in part by a fuller discussion of white pigments, including the debated question of regulations for the use of lead paints, and a new paragraph on fillers and extenders. Prof. J. F. Thorpe's article on phenols has grown from 10 to 13 pages, and Dr. Hewitt's article on quinones from 45 to 50 pages. Still more considerable expansion is found in the article on photography, which has grown from 35 to 51 pages; and the 10-page article on radioactivity now covers 23 pages (under the heading of radiology), mainly as a result of the addition of a 12-page section on X-ray spectroscopy, over the initials of Dr. E. A. Owen. Only one important example of shrinkage has been detected by the reviewer, namely, an omission of 7 pages on Scheele's method of preparing phosphorus, the details of which are now disposed of in two lines, by a statement that "Full details of this practically obsolete method were given in the last edition of this work." Chemists and others will be glad to add the new volume to their shelves, and will find that the revision has added substantially to its value.

Algebras and their Arithmetics. By Prof. L. E. Dickson. (University of Chicago Science Series.) Pp. xii+241. (Chicago: University of Chicago Press; London: Cambridge University Press, 1923.) 2.25 dollars.

THE existence of various systems of algebra, in which the commutative and associative laws of ordinary algebra are not assumed to be valid, has been known to mathematicians since Hamilton expounded his theo of quaternions. Such systems of non-commutati and non-associative algebra, based on a set of postula consistent with itself, are now termed *linear*, and t general entity of a linear algebra, a hypercompl number, marks the final stage in the evolution number. The first half of Prof. Dickson's book e pounds the theory of linear algebras and explains t terminology adopted in their classification. On moderate mathematical attainments in the reader a assumed, and, apart from the development of t subject-matter, the book will be of great value to tho interested in the foundations of mathematics.

The theory of arithmetics of algebras has bee surprisingly slow in its evolution. Naturally, t arithmetic of quaternions received attention first, successful theory being obtained by Hurwitz in 189 In passing to the arithmetic of any rational algebra t first main difficulty lies in rightly defining the integr elements. The early attempts of Du Pasquier soo led to insurmountable difficulties which are discusse by Prof. Dickson. By adopting a new definition t author has been able to develop a new arithmetic theory, valid and self-consistent in any ration algebra. As yet the theory is only in its infancy: leaves open a promising field for the research worker.

W. E. H. B.

The Book of the Wandle: the Story of a Surrey Rive By Dr. J. M. Hobson. Pp. xii+196+16 plate (London: G. Routledge and Sons, Ltd., 1924. 10*s.* 6*d.* net.

THE short Wandle river is historically of some import ance, and Dr. Hobson has honoured it by writing a boo about it. Owing to its rapid fall it has worked number less mills from time immemorial, and we should hav wished to have learned more about it as a source o water-power, such as that given by Close in connexio with the Southampton Itchen. Otherwise we hav in this book a comprehensive account of the Wandle' genesis and geology, its fauna and flora, its industrie and its many literary and other associations. Writte in popular style, it contains much valuable information collected mostly from the Proceedings of the Croydo Natural History Society, which is to be congratulate on the valuable work that its members have done.

The author rightly points out that intermitten bournes often show the extended courses of present-da dwindled rivers, and the Croydon Bourne shows th former course of the Wandle. If ever it came ove what is now Pebble Coombe may be doubtful, althoug Chipstead valley, Smitham Bottom valley, and Cater ham valley no doubt once fed the river. As the valley from Marden Park furnishes so much water to the Bourne now, sufficient importance perhaps has not been given to this branch of the former Wandle, as we should imagine that this branch was of later persistence than that from Merstham, although we recognise that the latter pass is a good deal lower than the Marden Pass.

We may point out that a vallum of the Romans was not necessarily made of stone, although Dr. Hobson thinks that such places as Walleton (Wallington) derive their names from the "Welsh," who were left in possession of them by the Anglo-Saxons. The book is well illustrated, and is full of information relating to the wide area drained by the little river which it describes.

Manual of Land and Fresh Water Vertebrate Animals of the United States (Exclusive of Birds). By Prof. H. S. Pratt. Pp. xv+422. (Philadelphia: P. Blakiston's Son and Co., 1923.) 6 dollars.

The naturalist frequently finds that to learn to identify species is a most difficult task, and yet nothing is more important to his work. He finds that species are not separated merely on shape and colour, but on structural peculiarities which frequently are connected with particular habits. This is especially the case in vertebrate animals, which in Great Britain, with its very limited number of forms, may be identified in a haphazard manner by elimination. This is impossible in a country where different climatic areas interdigitate and where there are many species, as the United States, which for the purpose of the naturalist is a continent. Here Prof. H. S. Pratt "fills the bill" by his "Vertebrate Animals of the United States," which, however, omits its birds. A short account of each group is given, the anatomical features dividing it up into sub-groups and families being usually illustrated. Where necessary, special features for families are described and then follow keys to the genera, descriptions of the same and keys to their species. The whole closes with a good bibliography and a glossary of technical terms. The short descriptions of each species, with mention of their geographical distributions and habitats, are excellent, and the tabulation of the sub-species most useful. We learn that there are about 600 species of freshwater fishes, 70 of newts and 61 of frogs and toads—we are given a key by which their tadpoles and eggs can be identified—300 reptiles and a wide series of mammals belonging to 9 orders. We characterise this publication as a book for ready reference, such as should be on the shelves of all American naturalists.

Automatic Telephone Systems. By William Aitken. Vol. 3: Large Multi-Office Automatic Systems; Semi-Automatic Working; Miscellaneous Systems; Lay-out and Wiring; Power-Plant, Traffic. Pp. xv+239. (London: Ernest Benn, Ltd., 1924.) 55*s.* net.

The Strowger Director System of automatic telephony is the system which, after very careful consideration, has been adopted by the British Post Office. It is manufactured by the Automatic Electric Company of Chicago and the Automatic Telephone Manufacturing Company of Liverpool. This was the system which the author described in volume i. of this work. In the volume now before us he discusses large "multi-office" automatic systems and semi-automatic working. Practically all the important systems which are in use, or are nearly ready to be brought into use, are described. The work will be of help to experts. Standardisation is still a long way off. On the Continent the rotary system with switches for 500 lines is popular, and in the United States the panel system is widely used. The author discusses the question of metering calls. In the United States, as a rule, with automatic systems, the calls are not registered. This saves time, and the plant is therefore more efficient. In Great Britain, meters have always been considered necessary because of the introduction of the message rate system. More complicated systems of tariff are, however, being proposed, but before being adopted it will be necessary to convince the consumer that they are equitable.

The First Days of Knowledge: as Narrated quite simply for Young Readers. By Frederic Arnold Kummer. (*The Earth's Story*, Vol. 2.) Pp. 314. (London: Hodder and Stoughton, Ltd., 1923.) 7*s.* 6*d.* net.

This is the second volume of a series of three called "The Earth's Story," of which the first was "The First Days of Man." In a preface to parents, the author explains that his object is to place before young readers a picture of the growth of civilisation in a form which will appeal to the imagination, stimulate thought, and at the same time link up with previous knowledge. This volume, after two introductory chapters, begins with the discovery of bronze; but in dealing with the growth of civilisation from that point onward the treatment is by subject and not chronological. Certain typical inventions, weaving, the water clock, the discovery of silk, irrigation, writing, and so on, are taken one by one and treated imaginatively and, on the whole, accurately. The chapter on religion might not perhaps pass the strict critic in all its detail, but this is perhaps out of deference to young readers—or their parents. It is, however, a little disconcerting to find Constantinople situated in Asia Minor.

Plane and Solid Geometry. By Prof. Walter Burton Ford and Charles Ammerman. Edited by Earle Raymond Hedrick. (Mathematical Texts Series.) Second revised edition. Pp. xi+356+xxviii. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 7*s.* 6*d.* net.

This is a second edition of a pleasant book. There is nothing very startling in the treatment or sequence, except that the "Pythagorean Theorem" is artificially postponed, apparently so that the authors might give an alternative proof based on proportionals. This is a mistake, because Pythagoras's theorem is the one thing that beginners in geometry get excited about, and its place is as early as is consistent with logical presentation. The alternative proof could have been inserted all the same.

The solid geometry is particularly well done, and the solid diagrams are very realistic. There are numerous applications to practical problems of life and of science, a brief historical sketch, and some useful tables.

S. B.

Cancer Research at the Middlesex Hospital, 1900–1924: Retrospect and Prospect. Compiled by members of the Staff of the Hospital and Medical School and issued by the authority of the Cancer and General Research Committee. Edited by W. Sampson Handley. (Published for the Middlesex Hospital Press.) Pp. ix+90+9 plates. (London: John Murray, 1924.) 3*s.* 6*d.* net.

This small work gives an account of the work on cancer at the Middlesex Hospital, particularly from 1910 to 1923, and incidentally since 1792, when Mr. Samuel Whitbread first endowed wards for the reception of cancer patients, who could remain "until relieved by art or released by death." The record is one of general progress at the Middlesex Hospital, and the book seems to be designed for the lay reader instead of the scientific worker. The financial needs of the cancer department are emphasised in a special chapter.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Physical Nature of Verse.

VERSE as it comes from the speaker consists of currents and vibrations of air in front of the mouth, and of vibrations that are transmitted outward. All that passes from the speaker to the hearer is contained in the air vibrations. The first step in the study of verse must be the purely physical one of registering and analysing the air-vibrations.

The first investigation of this kind was made at Yale University by tracing off a gramophone record of *Cock Robin*. On a gramophone disc the speech vibrations are contained in the sidewise movements of a groove that runs around the surface of the disc. The disc is placed in the apparatus and rotated very slowly. A steel point follows all the movements of the groove. A long lever attached to this point records these movements with a magnification of 300 times on a moving strip of paper. The line on the paper thus gives an immensely magnified image of the air vibrations.

In the speech tracing the lengths of the sounds are measured and expressed in thousandths of a second; this gives the durations of the sounds. In the vowels the long vibrations register low tones, the short vibrations high tones. By measuring the lengths of the vibrations the pitch of the tone in the vowels is obtained. The amplitudes of the vibrations of the vowels are also measured: this gives some indication of the relations of loud and soft. The results for the first three lines are given in the accompanying table. The first line gives the sounds in the ordinary spelling; the second gives the duration of each sound. The third indicates the average pitch, and the fourth the maximum amplitude. The last line gives the impression on the ear.

	Wh	o	k	i	ll	ed	C	o	ck	R	o	b	i	n ?	
Duration in $\frac{1}{1000}$ sec.	10	189	119	154	74	0	53	126	101	74	140	49	56	74	770
Average pitch		333		555	555			238			186		179	179	
Amplitude		4		6	1			5			5		3	2	
Judgment		strong		strong				weak			strong		weak		

	I	,	s	ai	d	th	e	sp	a	rr	ow,
Duration in $\frac{1}{1000}$ sec.	452	210	0	105	81	32	84	291	170	11	294
Average pitch	55 to 250			189			189		189		192
Amplitude	7			5	1	1	2		5	2	6
Judgment	strong			medium			weak		strong		strong

	W	i	th	m	y	b	ow		an	d	a	rr	ow	
Duration in $\frac{1}{1000}$ sec..	108	60	56	74	291	140	490	11	382	120	189	39	331	420
Average pitch	189	476		179	179		143		189	189	194		143	
Amplitude	2	4	1	1	5		4		2		3		6	
Judgment		strong			strong		strong		medium		strong		strong	

The first sound *Wh* is almost inaudible and can scarcely be found in the curve. The second sound begins with small waves, but rises rapidly to an amplitude of 0·4 mm. It has a rather high average pitch of about 333 and is the longest sound in the line. The curve corresponds to the judgment *strong*. The *k* with a duration of 0·119 sec. is the longest consonant in this line, that is, it is also a strong sound. The *i* is still louder and higher than *o* and is almost as long. The *ll*—short and soft as always—has a high pitch, and is therefore strong. We thus find four strong sounds, one after the other. The whole region is justly to be called a raised portion or a hill in the curve of energy.

Then follows a valley. The *C* is short. The vowel *o* has a somewhat long duration and good strength but falls about an octave in pitch. The following *k* has a medium length.

The second hill is marked specially by the length and strength of the vowel *o*. The pitch conforms to the melody of the whole sentence, which begins high and then sinks. The last valley contains the short low and weak vowel *i* and the quite similar *n*. A long pause follows.

The second and third lines are analysed in a similar way. The results show that the verse is to be considered as a flow of speech of varying energy so adjusted that regions of greater energy alternate with regions of less energy. The regions of greater energy are louder, have longer sounds, and are higher in pitch. The curve of energy is approximately as shown in Fig. 1.

The next investigations were of a graphic record of *Somebody said that it couldn't be done*. The analysis showed that a fourth factor of energy is to be added, namely, precision of enunciation. The regions of greater energy show more precise enunciation in contrast with the regions of less energy with negligent enunciation.

In order to express the rhythmical effect of verse we can use a concept familiar in physics. The centre of gravity of a body is a point in which the entire mass of the body can be considered to be concentrated for the purpose of investigation. The centre of gravity is an example of a centroid of forces, a

ɔ ept familiar in mechanics, magnetism, electricity,
t
pplied to verse the centroid will represent the
u of all the factors—intensity, pitch, duration,
r ision of enunciation—as concentrated in a point.
n varying course of speech energy there will be a
ɛps of points, each of which will represent a moment
greatest energy.
he simplest English poetical line consists of a
ntity of speech-sound distributed so as to produce

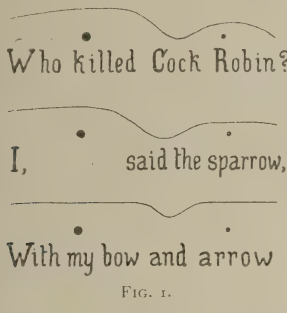

FIG. 1.

a effect equivalent to that of a certain number of
p nts of emphasis at definite intervals. With this
v w of the nature of English verse all the stanzas of
ck Robin can be readily and naturally scanned
a having two centroids in each line. The line
Somebody said that it couldn't be done contains four
centroids.
To the speaker and the hearer the flow of verse may
t treated in its rhythmic effect as a series of
centroids.
A more elaborate study has just been made of the
st line of Hamlet's *To be*. The factors contributing

	T	o	b	e	or	n	o	tt	o	b	e	th	a	t	i	s	th	e	qu	e	s	ti	o	n
Slowness			+	+	+			+		+	+				+				+	+	+	+		
Loudness					+		+				+							+		+	+			
Pitch					+		+				+							+						
Precision	+		+			+		+		+		+		−		−	−		+		+	+		
Energy	Strong					Weak	Strong		Weak	Strong		Weak			Strong		Weak		Strong				Weak	

ɔ greater energy are found to be: (1) Increased
owness of sound change (longer sounds); (2) in-
eased loudness; (3) raised pitch; (4) increased
recision of enunciation. The neighbouring table
ndicates by + the presence of these factors at the
uccessive phases of the record. The positions of the
entroids have been worked out with some precision.

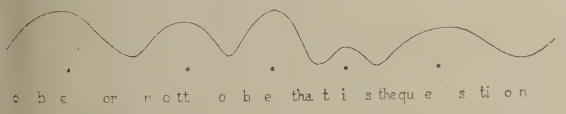

FIG. 2.

he distribution of the current of energy with the
ositions of the centroids is indicated with some
pproximation in Fig. 2.
These investigations of verse show that it is purely
matter of rhythm; it has no metre. The usual
cheme of prosody with feet, syllables, iambus,
rochee, etc., is a fantastic fabric of fancy without
he faintest foundation in fact.

E. W. SCRIPTURE.

University of Vienna.

A Possible Origin of Contracted Burials.

No explanation why the people of the palæolithic and many succeeding ages adopted the custom of always burying their dead in the contracted position has yet been universally accepted by archæologists. The reason given by some is that this is the sleeping posture; that the deceased had been thus trussed (by cords which have perished) to prevent his getting up inconveniently to haunt the upper world; or that it was to economise grave-yard ground—of which by the way there could have been then no scarcity, since there were no cemeteries. A larger body of opinion holds that this position was adopted because in being that of the infant during gestation, the dead was being symbolically returned to the womb of Mother-earth. The latter of these suggestions seems to me to credit prehistoric peoples with more knowledge than they were likely to possess; for how many even of our own uninstructed in gynæcology are aware of the embryonic position? Had palæolithic man—who inaugurated the custom—possessed that knowledge, ought he not to have buried his dead in the final posture of gestation—head downwards? Nor have we any authority for believing that the idea of the dead returning to the womb of earth ever at that early period entered his imagination. There occurs to me another possible origin for the custom.

In New Guinea I have seen many natives in sleep and during sickness; they invariably lay—generally on the right side—with their legs drawn up towards the chin; and when ill, close to a warm fire with the hand supporting the head on a wooden or other pillow. It is well known that this attitude affords instinctively the best relief to a sufferer from abdominal or thoracic pain. I witnessed few burials, but I was a close observer of one interesting and touching spectacle. When at anchor in February 1887 in Milne Gulf, a few hundred yards south of Wagawaga, my attention was arrested by the sound of loud and prolonged wailing proceeding from the village. Some hours later a small canoe put off from it heading towards our anchorage, opposite which (I then observed) a grave had been freshly dug a few yards from the strand.

The canoe, containing a figure seated in the bow and another in the stern, was slowly propelled from the stern by a youth wading in the shallow margin of the sea, while a crowd of villagers accompanied it along the shore giving utterance to piercing and woeful cries of *kaione* (adieu). I had a boat lowered and drew in towards the place of interment. As the canoe approached I could see that the figure in the stern was the wailing mother, and that in the bow an elderly man (the father?) who supported between his legs and against his chest the body of a woman (his daughter?) in a closely contracted attitude, her folded arms resting up against her breast. She was nude except for a fine many-tinted petticoat (*kuri-kuri*) such as is used on festive occasions, and a costly nose-pencil.

On the funeral bark reaching the landing spot, the

body was gently lifted out with demonstrations of affection by four men. As they bore it towards the grave, which was more or less circular in shape and some 4½ feet deep, I could clearly see that the cadaver, without any cords or bindings whatever around it, was still held by rigor mortis in the attitude in which it had died. The body was deposited in its last resting-place in this sitting attitude without any unflexing of its limbs. Over it were laid several grass petticoats, but no other grave furniture so far as I observed, before the earth was filled in.

It seems to me not improbable that where among primitive peoples the dead were not retained long above ground after breathing their last, the contracted position, in which Death usually overtook his victims, stiffening limb and muscle in that attitude by the rigor mortis—a rigidity requiring force to abate—came to be adopted as the natural, if not magical, position for sepulture (whether laid on right or left side or set erect) rather than from any idea of the deceased's position when an embryo, or of "his returning to the womb of earth."

HENRY O. FORBES.

Deanway, Beaconsfield, Bucks.

The Choice of Wave-lengths for Achromatism in Telescopes.

DURING the past summer, in the Transactions of the Optical Society, Mr. J. W. Gifford has directed attention anew to the question as to the two wave-lengths most suitable for achromatising telescope objectives. Mr. Gifford has constructed telescopes in which the paraxial focal length for the D and E lines is the same, and, judging by the performance of such objectives, he considers such a choice superior to the more customary choice of the C and F lines. By a different path I have been led to a similar judgment, at least for telescopes of large aperture.

It is the purpose of this note to show that it is possible to meet the objection, which was made in the discussion, to the closeness of the D and E lines, and also to indicate certain relations which exist between the wave-lengths selected for achromatising and the type of achromatisation which results. The results are for a thin contact pair of hard crown and dense flint, and are deduced with the aid of Hartmann's interpolation formula.

The result of making the focal length the same for two different wave-lengths is to make the focal length a minimum for some wave-length intermediate between these two. On the blue side of this minimum the focal length increases more rapidly than it does on the red side, and as the wave-length of the minimum is made greater, the curve which represents the variation in focal length is made noticeably more flat. From two such curves with minimum wave-lengths of 550 and 560 millimicrons respectively, the data which is represented on the accompanying diagram (Fig. 1) was obtained.

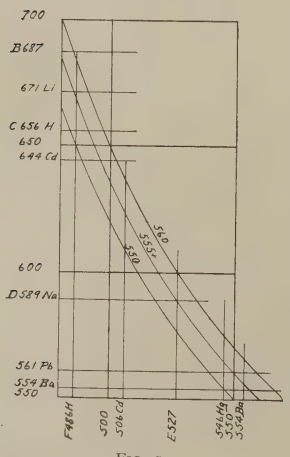

FIG. 1.

On the diagram the curve marked "560" represents all possible choices of wave-lengths which can be used to bring the minimum focal length of the achromatised doublet to a wave-length of 560 μμ. If, for example, one wishes to use the E line and to have the minimum at 560, then one must make the focal length the same for 527 and for 600 μμ. Or, the choice of B and F for achromatising will make the wave-length of minimum focal length just a trifle greater than 560 μμ. In a similar manner, the curve "550" represents all possible choices of wave-lengths which will give the value for the wave-length of the minimum focal length. The intermediate curve, marked "555+", is drawn with the same form as the other two and passes through the point of intersection of D and E. This curve, then, represents the possible combinations of wave-lengths which will be equivalent to the combination of D and E.

Evidently the red lithium line and the F hydrogen line will give very nearly the same result as the combination of D and E, and there does not seem to be another convenient combination which will so serve. However, hydrogen tubes are easily obtained, and the lithium coloured bunsen flame can be maintained for hours at a time by wrapping around the burner a small square of paper which has been previously soaked in a solution of lithium chloride and then dried, feeding the paper slowly up into the flame as it is burned away.

I may add that the aberrations should be corrected for a wave-length in the neighbourhood of that for which the focal length is a minimum. If the hydrogen tube be contaminated with a little mercury, it will furnish the mercury line at 546 μμ, by means of which a value of the index of refraction could be obtained not differing greatly from that at the minimum.

T. TOWNSEND SMITH.

Brace Laboratory,
University of Nebraska,
September 10.

Lake Victoria and the Flow of the Yala River.

WITH considerable diffidence I venture to offer an explanation of the diurnal current change described by Dr. G. D. Hale Carpenter in NATURE of August 30, p. 311. In equatorial regions a twelve-hourly barometric oscillation attains its maximum amplitude of approximately 0·9 mm. of mercury. The maxima occur daily at about 9.10 A.M. and P.M. Thus, in the absence of major barometric fluctuations, the pressure is on the decrease from about 9 A.M. until early in the afternoon at a time corresponding approximately with the time of reversal of the current. It follows that the lake level will be rising during this period, and hence an overflow into the deltaic marsh. The volume of river water entering the swamp should be sufficient to account for the reversal occurring about one hour previous to the time of the barometric minimum.

A second factor that should augment this effect is differential evaporation between lake and swamp. The shallow water of the latter would probably grow warmer during this period and lose more by evaporation than the deep water of the lake.

Further information as to the behaviour of the current during the night—the time of the diurnal rainfall (if this be regular) and the time thereafter when the river level rises—might materially assist in solving the problem.

NORMAN L. SILVESTER.

Aber, Cavendish Ave., Finchley, N.3.

WITH reference to Dr. Hale Carpenter's letter (NATURE, August 30, p. 311) on the subject of Lake Victoria and the flow of the Yala River, the following considerations occur to me. There is a fairly regular diurnal fluctuation in the waters of the lake. At the

el of the Kavirondo Gulf the average level is a few es higher in the afternoon than in the morning. the open shore of the lake at Entebbe the varia- is naturally smaller, but the figures given by Dr. penter (which appear to be in metres) show a trace f. I attributed this variation to the alternation of l and lake breezes, which drive the water away n the shore during the night and early morning and ards the shore during the afternoon. From this or alone one would expect the direction of flow ween the Yala swamp and the lake to be from the mp in the morning and towards it in the afternoon, the reverse of that found by Dr. Carpenter. If channels between swamp and lake are short and p, there might be a regular circulation of the water. diurnal variation of temperature in a shallow mp is much greater than that in the main body of e water. The swamp water cooled during the night ld flow towards the lake as a bottom current and ld be replaced by a surface flow from the lake to swamp, the latter only being observed by Dr. penter. In the afternoon the heated swamp waters ld flow towards the lake as a surface current and cooler lake water would form the bottom current. f this solution is not tenable owing to the length or llowness of the channels, the problem becomes re difficult. Mr. Silvester suggests that the ernation of flow is due to the semi-diurnal wave of ssure. This pressure variation, being approxi- tely equal over both lake and swamp, could not press one relatively to the other unless there is some tor peculiar to either lake or swamp. The only h factor that occurs to me is the presence of gases h as are usually found in the mud of a swamp. The gh pressure and low temperature of the morning uld decrease the volume of the gas and lower the el of the swamp waters. During the afternoon the w pressure and high temperature would increase the lume of the gas and raise the level. The production gas should also be greater during the day, while ing to the vertical circulation, the loss to the air ay perhaps be greatest at night. The effect would aided to some extent by the thermal expansion of te swamp water due to its greater range of tempera- re. I do not know enough about the volume of gas nerated by a tropical swamp to say whether it is fficient for a reversal of the direction of flow in this anner. Differential evaporation could not solve the oblem, as its effect would be, not only very small, t in the wrong direction. C. E. P. BROOKS.

Meteorological Office,
South Kensington, S.W.7,
September 15.

Analytical Sound Records.

THE compound resonators exhibited at the nversazione of the Royal Society in June last have roved useful for obtaining photographic records of usic and speech which clearly exhibit their con- ituent frequencies. Fig. 1 is a record of a scale

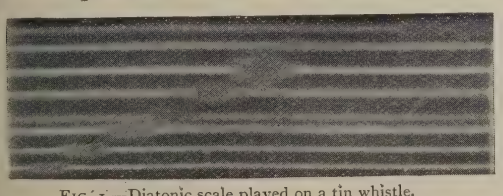

FIG. 1.—Diatonic scale played on a tin whistle.

layed on an ordinary tin whistle, which, contrary o popular opinion, is known to produce nearly pure otes free from overtones. It will be noticed (1) hat there is no overlapping of the notes, each note, when sounding, leaving all the resonators undisturbed except the particular resonator tuned to it. This applies even where the interval is only a semitone; (2) the sounding of a note does not affect the resonator an octave below or above. This observation settles a point in resonance concerning which, I believe, there has been some doubt hitherto.

Fig. 2 shows a record obtained by playing an air

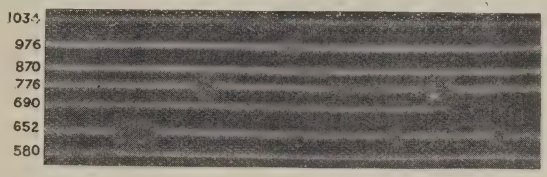

FIG. 2.—"There's no place like home" played on a tin whistle: seven resonators covering the diatonic scale.

on the whistle. It will be seen that the response of the various resonators is very quick, requiring not more than 0·05 sec. for its full establishment. The slight longitudinal overlapping observed in some notes is merely an effect due to the fact that the patches producing the lines are elongated in the direction of the lines themselves, in order to increase the illumination. The high damping factor of the mica reeds produces an equally instantaneous cessation of the note picture when the note ceases to sound. It will, therefore, probably be found possible to record even demi-semi-quavers by this method. An attempt to record a rather fast piece of music is shown in Fig. 3.

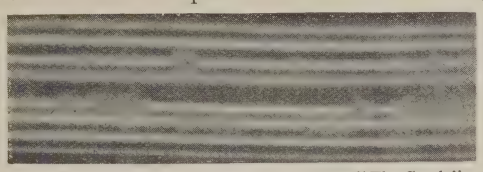

FIG. 3.—Photographic record of a passage from "The Gondoliers" (Gilbert and Sullivan) using eight resonators.

I have, so far, constructed efficient resonators of this kind extending over four octaves. It is obvious that if the method can be made to cover the whole range of musical sounds, a very rapid and convenient method of sound analysis will be at our disposal.

E. E. FOURNIER D'ALBE.

Westergate House,
Kingston-on-Thames.

Mendelism and Evolution.

As a member of the British Association who had the privilege, by the generous hospitality of Mr. Richard Marsh, of seeing the white and brown Indians from Panama at Mr. Marsh's temporary residence near Prescott, Ontario, I should like to comment briefly on Mr. Julian Huxley's letter on the subject in NATURE of September 27. It seems to me that there is some degree of inconsistency in Mr. Huxley's remarks. He states that all authorities are agreed that the condition of the white Indians has no racial significance, and yet finally concludes that the case shows how evolutionary change may originate in single mutations of considerable magnitude. I suppose that the phrase "has no racial significance" means that the difference between white and brown Indians is not in any sense or degree similar to the differences between the various races of mankind. It would follow, therefore, that however interesting and important the white mutation may be, it does *not* show that the evolution of human races has had anything to do with mutations of this kind.

It is true that blue eyes are found to be a simple recessive, and many human abnormalities are

known which behave as single Mendelian characters. The distinguishing peculiarity of the white Panama Indians is chiefly, but apparently not entirely, a pigment character. But I believe that there is no human race whose pigment character behaves in crosses with other races as a simple Mendelian recessive; and I believe there is no human race which is distinguished from other races by pigmentation alone. Prof. Karl Pearson has maintained that the white European originated as an albino from a dark race. But it seems proved that the white character of the European does not segregate completely in crosses with other races, and therefore does not behave as albinism. Mr. Huxley states that the white Indians mate almost wholly with other whites. There is a certain amount of separation, but the white girl among the group which Mr. Marsh has with him is the daughter of parents who are both normal brown individuals, and who are both with her. Each of these parents had one white parent.

I hope to give further study to the matter, but so far it seems to me that this case tends to demonstrate the difference rather than the similarity between mutation and evolution. J. T. CUNNINGHAM.

October 1.

The Indian Institute of Science, Bangalore.

IT is a matter of sincere pleasure to those who are students of science in India to read in NATURE of August 2 an account by Dr. Morris W. Travers of the early working and the history of the Indian Institute of Science.

All those who have seen this splendid Institute have a word of praise and admiration for Dr. Travers, who equipped it so that it continues to be one of the finest laboratories in the British Empire. The libraries attached to this Institute are second to none in the world.

That these laboratories will turn out scientific work of the highest importance is only a question of time. With increasing consciousness of the importance of research in India, and the enlarged reforms which give Indians greater scope for intellectual and political activities, the Institute is sure, in time, to fulfil the hopes which its equipment inspires.

When the political status of India is that of a free Dominion in the British Empire, the British names which will be written in golden letters for bringing about that happy state of affairs will not be those of statesmen only, but will include also prominent chemists such as Crum Brown for giving us Sir P. C. Rây, the founder of a school of chemical research in India, Donnan and Thorpe for inspiring the largest number of physical and organic chemists in India, and above all Travers, for building the Indian Institute of Science at Bangalore. S. S. BHATNAGAR

(Director of University Chemical Laboratories, The Panjab University, Lahore; and Hon. University Professor of Chemistry, Benares Hindu University).

Benares, September 9.

Gravity Measurements in Deep Water.

ATTEMPTS at determining the gravity force over the oceans do not seem to have met with unqualified success. The following suggestion, so far as I know, is new. Possibly some objection to its use may exist.

A pendulum of the usual type is suspended within a steel vessel of sufficient strength and lowered on a sounding wire to the bottom of the ocean. The verticality of the steel vessel is secured by suspending it from a tripod which takes up a stable position on the sea-floor.

Vanes attached externally to the steel vessel ke it from taking up a vibratory motion, and a surroun ing screen protects it from possible currents. With the vessel there is a photo-electric cell; a small dr battery and lamp; and a simple electromagnet arrangement for the release of the pendulum, whic while being lowered, is held by this release in deflected position. A recording thermometer is al contained within the vessel. A single insulated wi makes connexion with the ship.

When the pendulum has been for some time the bottom, so as to take up a constant temperatur and to allow for initial settlement, it is released by momentary current from the ship. It now falls int vibration, and at each vibration screens the phot electric cell from the lamp. The periodically inte rupted current so created reaches the ship throug the connecting wire.

It is desirable to compare these vibrations wit the vibrations of a standard pendulum upon th land. This is accomplished by means of wireles The current from the submerged apparatus, afte reinforcement, operates the wireless of the ship, an so is transmitted to a station on the land. O alternatively, the vibrations of a shore pendulu are transmitted to the ship and the comparis carried out on board. J. JOLY.

Trinity College, Dublin,
September 12.

The Institute of Catalan Studies at Barcelona.

IN June last, Prof. Dwelshauvers, the Belgia philosopher, was dismissed by the Spanish Directorat from his position of director of the Laboratory o Experimental Psychology at Barcelona. The reason given for his dismissal were that his researches wer frivolous, and that as the results were only publishe in a foreign periodical, *L'Année psychologique*, th work must stop on grounds of economy.

The Laboratory was under the patronage of th Institute of Catalan Studies, against which a genera attack has been made by the Spanish Government o the ground that its tendency is separatist and sub versive. Public opinion in Barcelona hotly resented the action against Prof. Dwelshauvers, and one hundred and twenty-five professors and science teachers signed a letter of sympathy and protest, which was published in the daily press.

The Directorate professed to consider this letter an insult to the military government, and it was announced that unless an apology was publicly made by the signatories they would be dismissed from their posts. The professors replied that their action was dictated by sympathy with a colleague and had no political significance, and that therefore they had nothing to withdraw. In consequence they have all been dismissed.

Only those who know the work of the Institute of Catalan Studies can appreciate the result of this: practically all the higher education of the Catalan provinces has ceased, for, with the exception of the Castillian University in Barcelona, the whole higher and technical education was in the hands of the Institute.

Among those dismissed are several with reputations outside Spain, including S. Pi i Suñer, Director of the Advanced School of Agriculture; S. Campallans of Louvain and Charlottenburg; Prof. Pau Vila of Geneva and Grenoble; and Prof. Pompeu Fabra, the well-known philologist and the virtual creator of modern literary Catalan.

JOHN LANGDON-DAVIES.

Geology and Evolution.[1]

By Prof. W. W. WATTS, F.R.S.

WHILE astronomy has given us the conception of illimitable space, it has done much to d troy what has been called the anthropomorphic v w of creation. Geology, on the other hand, has owed us with an almost limitless conception of me, but has done something to rehabilitate the im- p tance of man as the highest product yet reached in t long history of the earth.

This it has done, in the main, through the intense r lity that it has given to the conception of evolution. Although several authors, and two in particular, have pointed out that such a conception could not have been f med without the postulates of time and continuity oexistence contributed by geology, it is scarcely real- ed how much geological labour on the life of the earth, ad on life on the earth, as summed up by Lyell and ouped and presented by him in his great work on "The Principles of Geology," was necessary to give to olution a concrete and cogent application. The f ction of this labour could scarcely be better indicated tan by the position of geology as displayed in Lyell's rlier editions. The modern reader of them is con- tually haunted by the feeling that the author was f ling and struggling for a single missing generalisation vich he failed to find; and although, in almost every anch of the subject treated, Lyell leads up again and ain to the missing conception, and though the facts ad inferences which he marshalled can now be seen t be marching on this great idea, he never quite sceeded in attaining it for himself. It was left for lurwin, than whom no one was more conscious of what l owed to Lyell, to see that the facts must rest on sme great single fundamental principle, to realise that is principle was evolution, and to apply it to his own anch, the development of life.

Lyell had proved that the long history of the earth recorded in the rocks revealed the operation of uses, small in relation to the earth as a whole, but rsistent, the majority of them still in action. It was further debt to Lyell that Darwin should bring in e continuous operation of small causes as the achinery operating and guiding the evolution of life.

Though the work of geologists, as summed up in yell, provided the starting-point for the conception of ganic evolution, it did not stop here. The idea of niformitarianism in which that work culminated was eant as a reaction against the fantastic operations stulated by the Catastrophists, and was never tended to imply that these causes in the past were ways balanced or distributed as they now are. There as in Lyell's statements nothing to indicate that enudation or earth-movement might not have been ore active at periods of the past, that organic change ight not accelerate or slow down, that there might ot be variations in the trends of continental or eanic development resulting in climatal and other anges, or that the very sources and intensities of nergy from outside or inside the earth might not eriously vary. Only, warrant must be found for all such suppositions with regard to the earth of the past from fuller study of the earth of the present. If we recognise the inner spirit which inspired the eloquent words of Lyell, when he had grasped that Darwin had supplied the one missing idea, we cannot fail to see that his Uniformitarianism included evolution as one of the "existing causes" to be taken into consideration.

The physiology of the earth, however, is that of a very complex organism, and we are sure that we do not yet know all the forces internal and external acting upon it, still less their relative value and intensity, their distribution and variation in the past, or the precise records which each is capable of imprinting on the rocks of the earth-crust. It is becoming clearer that there has been a periodicity in the stages of development of the earth-crust, and that on these great pulses of earth-life there have been imposed innumerable waves of smaller cycles; and that, on account of their interference with, or reinforcement of, one another, the simpler type of cyclic repetition which might have been looked for in the history is masked and broken and diversified by actual happenings of an infinite variety. Van Hise more than once complained of the tendency of geologists to adhere to single explanations of events, and advocated the necessity of considering the co-operation of many causes; and it may well be that in many outstanding problems such as past glacial or tropical periods, coral reefs, stages of earth movement, progression and regression of the oceans, we may find the ultimate explanation in the interaction of a number of "true causes."

During the long period of time comprised in the history from the Cambrian Period onwards, the slow and persistent evolution of plant and animal life went forward and left ample record in the rocks. To warrant a belief in organic evolution, we are no longer solely dependent on reasoning founded on existing organisms or on the facts of their ontogeny and distribution. As M. Marcellin Boule says in his work on fossil man, ". . . pour tout ce qui a trait à l'évolution des êtres organisés en général, le dernier mot doit rester à la Paléontologie quand cette science est en mesure de parler clairement. Les plus fins travaux anatomiques, les comparaisons les plus approfondies, les raisonnements les plus ingénieux sur la morphologie des êtres actuels ne sauraient avoir la valeur démonstrative des documents tirés de la roche où ils sont enfouis et disposés dans leur ordre chronologique même."[2] Although we are only too painfully aware of the innumerable chances that conspire to prevent an animal or plant from securing immortality by preservation as a fossil, the finding of better-preserved material, the more skilful preparation of it for examination, and the application to it of refined biological methods, such as careful dissection and the serial sections of Prof. Sollas, are giving us more complete and accurate knowledge than ever before. It may now be confidently stated that many of the most crucial links in the chain of evolving life are in our hands, that they actually lived in the past, and that their fossil forms show their

[1] From the presidential address, "Geology in the Service of Man," delivered to Section C (Geology) of the British Association at Toronto on August 8.

[2] Marcellin Boule, "Les Hommes fossiles," p. 453

relationship to their predecessors and successors. The time has come when Darwin's famous chapter on the "Imperfection of the Geological Record," an apology written with the most balanced criticism and unbiassed judgment, should be re-written and revised.

It is true that we seem as far as ever from unveiling the points of divergence of the great phyla, and we can but feel that the time from the beginning of the Cambrian Period onward is but a small part of the whole history of life on the earth. As with antiquarian research, each new discovery in geology, whether on the physical or the biological side, only brings these distant ages more fully into view and emphasises their modernity and their likeness to our own time. Hutton's famous dictum that he saw "no vestige of a beginning, no prospect of an end," is to-day more true than ever, when we regard the evidence of stratified rocks. But we know enough to convince us that within post-Cambrian time evolution has steadily proceeded from general to special, from simple to complex, from lower to higher efficiency.

In almost every subdivision of the animal kingdom, and in not a few branches of the vegetable kingdom, lines of descent and directions of specialisation have been made out, sometimes visibly operating throughout whole systems, but more usually through smaller divisions of the record; and this in the former kingdom not only among vertebrates but also among the invertebrates and even their lower sub-kingdoms. It may even be stated that in methods of defence, in food procuring, in the attainment of favourable positions and attitudes, something very closely imitating what would be expected on the doctrine of the origin of species by "survival of the fittest" has again and again occurred.

The essence of evolution is unbroken sequence, and when we consider the extraordinary delicacy of the adjustment of life to its physical and organic environment, the mutual interdependence of life forms, and the necessity to them of such factors as favourable range of temperature, food, climatic conditions, soil, and the continuity of the "element" in or on which they live, it is most wonderful that in the vast lapse of post-Archæan time it has been possible for life to exist continuously, and continually to evolve, throughout those long ages. And this in spite of the fact that, although the main chain has been unbroken, conditions have, in many cases, been so unfavourable that whole groups have flourished and died out, while others have become so attenuated that only a few survivors have been left, highly restricted in distribution, to burgeon out again when the unfavourable conditions were removed, or in other places where conditions have again become more favourable to them.

That life has survived continuously in spite of the vicissitudes through which it has been compelled to pass, and the frequent convergence upon it of unfavourable conditions, may well be taken to heart by those who fear that civilisation will be brought to an end by the misuse of the powers that itself has evolved. They may surely take courage and trust that the remedy for these evils will come, as it has in innumerable other cases, not from conventions and understandings that, as all history shows, will be mere scraps of paper, but from the intensive application to them of the very science which has evolved them.

Although the geological record is and possibly will always remain incomplete, it has yet proved remarkably representative, and certain outstanding facts have been made out which are sufficient to show that the lines of organic evolution as recorded in geology are in accordance with what is theoretically probable, and with those taken by the evolution of domesticated organisms and by human arts and inventions.

(1) There can be no doubt that the stages of organic evolution are correlated with, and were actuated by, the stages in the inorganic evolution of the earth itself; that climatic change was effective in inducing migration, and thus in sharpening the struggle for existence against both enemy organisms and changed physical environment; that extension and restriction of land and water areas in some cases brought about keener and more varied competition, change of habit or food, and in others the destruction of potential enemies and the securing of the advantages of a fair field for the survivors; and that activity of the earth-crust in such things as deposition and mountain building provided conditions for the existence of an increased range of varieties and the consequent struggle between them. If we are not allowed to say that this brought about the survival of the fit, it at least caused the destruction of the unfit.

(2) It may be stated as a biological law that every locality becomes "full" of life, forms arriving or evolving to take advantage of the special facilities offered. In consequence, resistance to the incursion of new forms, even if they are exceptionally equipped, is very great, and it is only occasionally that such new forms can make good their immigration. There are, of course, marked exceptions, but these generally occur when degeneration or overgrowth in size accompanied by neglect of means of defence has occurred, or when an area has been for so long sheltered from the wider and more general course of evolution that it has fallen seriously behindhand in the race.

The geological record gives indirect evidence of the same "filling" of areas in the past in the extraordinary slowness with which advanced types, that have eventually made great headway, established themselves after their introduction; the earliest fishes, reptiles, and mammals are cases in point. Imperfect as the first members of these groups undoubtedly were, they must, even shortly after their introduction, have possessed considerable advantages over the older and established forms with which they found themselves in competition. In size and strength they were doubtless inferior, and probably they must have taken long periods to make good their advantage. But in all such cases the new forms went for a long period into "retreat," and in face of the apparent slowness of their evolution and the bitter competition to which they were subjected, it is remarkable that they overpassed the troubles of racial youth, and eventually took the place to which they were entitled in the scheme of life. It seems justifiable to believe that there must have been at least some well-equipped types which did not survive competition in these early stages, but went under with all their promise of future success. We can easily imagine that the survival of such, had it

curred, may have altered the whole course of evolution and produced a life story very different from that we know to-day, and of which we ourselves form no small part.

(3) Not less remarkable than the period of "retreat" is that of booming development which at last came to each successful modification. In this connexion we can instance the *pleine évolution* of the graptolites, the echinoids, ammonoids, and belemnoids, the fishes, reptiles, birds, and mammals, each in its own time. Each slowly but surely built up its supremacy, and then intoned through long ages as the lord of creation in its own element and in its own day. Both the period of sanctuary and the subsequent boom can be closely paralleled by the case of many human inventions and in the occupations and history of mankind.

(4) While there are outstanding cases in which a line of advance is taken that is capable of successive improvements and leads on to continuous success, there are many others in which the line of advance, though temporarily advantageous, has only been carried through a limited number of stages. Eventually it has failed either by its inherent inadequacy or by imposing too heavy a burden on the economy of the organism that it was unable to bear the cost.

The only example I need quote, though there are many others, is the use of defensive armour, spines, plates, hooks, horns, etc. These provide an obvious method of resistance to attack, and this defensive attitude has been practised by one group of organisms after another, but always with the same disastrous result, the imposition of a fatal strain on the organism to meet renewed, perfected, and more vigorous attack. The spinose graptolites and trilobites, the armoured fishes and reptiles, are cases in point, and in the last of these examples, at least, victory rested with the acquirement of swiftness in movement, accompanied by increasing power of attack such as is given by the development of teeth or claws or both. Again and again in the Tertiary era one group of mammals after another, before, or more usually after, the attainment of great size, has taken to some means of sedentary defence, and in every case the cost of upkeep has been too great and the group has gone under. Every time the race has been to the swift, active, and strong, and those that trusted in "passive resistance," in "defence and not defiance," have gone under in competition with those that have been prepared to face the risks involved in attack. The fact that turtles and armadilloes have survived to the present endorses rather than vitiates the principle.

Other cases of rapid decline or sudden disappearance are more difficult to account for. The waning of the brachiopods but yet not their disappearance, the disappearance of the pteridosperms, the rugose corals, the belemnoids and ammonoids synchronising with the vanishing of many orders of reptiles, will long furnish subjects for research by biologists and geologists. It may well be that the explanation will often lie along biological rather than physical lines, such as those suggested for the graptolites; Lapworth pointed out that their disappearance—in spite of a brave effort of passive resistance—synchronised with the great development of fishes, and the assumption by them of many of the functions previously discharged by the trilobites. In other cases the explanation may be more in the direction of that given for the reptiles to be referred to later.

The rarity in the geological record of some of the stages in evolution, and the absence of others which must surely have existed, may receive some explanation from what has frequently occurred in the history of human invention. If variants arise and are subjected to intense competition, they have no chance in the struggle for existence unless they show rapid improvement and development of the favourable variations within a few generations. Hence the numbers exhibiting each of the early stages of change will always be few and the chances of their preservation slight. Those who have tried to work out the stages in the history of an invention, for example, will appreciate the rarity of "missing links" and the difficulty of filling in every step towards the later perfection. These are looked upon as "freaks" and, unless they present real and marked improvement, are never manufactured on a large scale. Their numbers consequently are few, and many of them are the victims of experiment and often do not survive the experience.

(5) Perhaps the most wonderful result disclosed by a study of the later part of the geological record is the steady and unbroken evolution of brain from the earliest vertebrate animals to the present. The exceeding slowness of the process in its early stages is not less wonderful than its acceleration during the latest stages of geological history. The disappearance of so many orders of reptiles at the end of the Mesozoic Period, at the close of a long and most promising chain of evolution, indicates that there was some inherent weakness underlying the line of evolution entered upon by them, which proceeded so far and favourably that it was impossible to retrace the path. This may well have been connected with the substance or construction of brain and nerve. If so, this side of evolution has to be seriously reckoned with, and it may be that the fundamental weakness of physical as opposed to intellectual evolution brought this flourishing and well-developed group to its end.

It has, of course, been suggested by Starkie Gardiner and others that the destruction of Mesozoic life types was brought about by physical changes; but, apart from the fact that the particular changes supposed by the former did not as a matter of fact occur, the entire explanation provides a cause utterly insufficient in comparison with the potency of organic struggle against creatures better endowed with warm blood, adequate brain substance, and the activity and enterprise springing therefrom.

In spite of the evidence of acceleration as the higher ranks of animals are reached, and in spite of the extraordinary efficiency of the human brain and all the benefits to the organism it brings about, we may well be appalled by the æons which have been used up and the millions of varieties which have passed away in the production of this, the most efficient scientific apparatus yet invented or evolved.

(6) If, however, it has taken long ages to evolve an animal capable of a broader geographical distribution than any other, with a constitution capable of withstanding the widest ranges of heat and cold, and of peopling the world from its tropical deserts to its polar

wastes; and to endow him with a brain by virtue of which he has made himself master of the earth and all its living inhabitants; it has taken no less time for the evolution of the many factors without which his present success would have been impossible. To pick out a single instance, probably few things in the whole story of life have been more fruitful in effect than the appearance of the grasses in late Eocene times, followed by their rapid evolution and spread in the Oligocene and under the direction of the critical events of the Miocene Period. Starkie Gardiner in an admirable paper first directed attention to the vital importance to the animal evolution of the world in general, and to the welfare of man in particular, of this step forward. It was followed by great changes in the insect world, by the rapid production of herbivorous mammals endowed with speed, great migratory powers, special dental and other anatomical adjustment to the new foods, and the institution in their herds of a discipline, subordination, and leadership which are almost tribal. These last qualities were rendered doubly necessary by the consequent rapid development of carnivora, and the need for "scrapping" passive and even active means of defence in order to secure the power, speed, and reserve necessary to follow their food harvests over great stretches of country. At the same time the habits and instincts thus brought about were those which man, by domestication, has been able to turn to his own ends. Thus at a blow, as the outcome of this stage of Tertiary evolution, there became available for mankind not only his chief plant food and drink, his luxuries as well as his necessaries, but also his chief animal foods, together with his aid from the speed, strength, service, and endurance of the animals which he domesticated, and to which he assumed the position of leader to the herd.

While with the aid just described it was possible for mankind to progress far on the road of civilisation, progress would have been stopped, and as a matter of fact was seriously retarded, until the discovery and utilisation of the solar energy stored up in the earth's crust during the Carboniferous and subsequent periods in the form of coal and other fossil fuels. The very exceptional conditions, climatal, geographical, and botanical, requisite for coal formation, occurred all too seldom in geological history, but it has so happened that few areas of the earth are devoid of coal belonging to one period or another; and the shaping of kingdoms and dominions has been such as to include supplies of fuel in most of them. Whatever may be the main sources of energy in the future, radiant, intratelluric, hydraulic, tidal, atomic, we have been largely dependent in the past, and probably shall continue to depend for many years to come, on that portion of the solar energy stored up by vegetation, and especially on that preserved in the earth-crust in the form of coal.

Again civilisation must have been greatly hampered or driven into a different course but for the agencies which have sorted out from the medley of materials of which the earth is composed, simple compounds or aggregates of compounds, or in rarer cases simple elements, in such a form that they are available for human use without the expenditure on them of excessive quantities of energy. The concentration of metalliferous ores, salines, and the host of other mineral resources has made perhaps the most important contribution of all to the latest stage—in good and evil—attained by civilisation.

Finally, doubt may be expressed whether man could have attained his present position if he had not made his appearance comparatively soon after a period of intense earth activity, when broad areas of newly raised sediment were available for occupation, when the agents of denudation and renewal were in active operation, and when a wave of rapid organic evolution was active. A conjecture may also be permitted that human evolution itself was probably hastened by the latest climatal severity through which the earth passed, the effects of which are only slowly passing away.

Much of what has just been said may revive recollection of an old Swiss guide-book which praised the beneficence of Providence in directing the dreaded avalanches "into the desolate and uninhabited valley of the Trumleten Thal and in sheltering from them the beautiful, fertile, and inhabited valley of Lauterbrunnen." However, it is far from my intention to imply that "everything is for the best in this best of all possible worlds," but only to point out, in reviewing the long chain of events of which we see the present end-product in civilised man, that within the ken of the geologist there have been many critical stages in the earth's history when any marked change in the conditions which then prevailed must inevitably have reacted profoundly upon the development of the human race when at long last it stepped out from the lower ranks to take the earth as its rightful possession.

In the course of the development of both the economic and the scientific sides of geology, the principles discovered and elaborated have fertilised and enriched human thought as expressed not only in other sciences but also in the sphere of literature. As it has become more precise and is able to give a more accurate and detailed picture of the stages through which the earth passed during the long story unfolded by the study of the stratified rocks, it has shown that the earth, though only a minute fraction of the visible universe, has had a wonderful and individual history of its own. The keynote of this history is evolution, the dream of philosophers from the earliest times, now passed from the realm of hypothesis into that of established theory.

We are able to watch the evolution of the oceans and continents, of the distribution of landscape and climates, and of the long succession of living beings on the earth, throughout many millions of years. During these ages we see the action of the same chemical and physical laws as are now in operation, modified perhaps in scale or scope, producing geographical and biological results comparable with those of to-day. Hutton and Lyell discovered for us in the present a key to unlock the secrets of the past; the history thus revealed illuminates and explains many of the phenomena of the present. The outcome of it all is to endow man with a simple and worthy conception of the story of creation, and to fill him with reverence for the wondrous scheme which, unrolling through the ages, without haste, without rest, has prepared the world for man's dominion and made him fit and able to occupy it.

Liquid Air in Mine Rescue Apparatus.

THE Mines Rescue Apparatus Research Committee which was appointed by the Advisory Council for Scientific and Industrial Research to inquire into the types of breathing apparatus used in coal mines, and to determine experimentally the advantages, limitations, and defects of the several types, has recently presented its third and final Report.[1] In the first report, attention was directed to certain serious defects in rescue apparatus, and to the training of rescue brigades; and the lines along which improvement in design was necessary were indicated. In the second report, methods of testing compressed oxygen apparatus were proposed and descriptions of new and improved appliances were given. The third report deals principally with the use of liquid air and liquid oxygen in mine rescue apparatus, and will prove of great interest not only to mining engineers but also to all who have occasion to use liquid air and oxygen.

The report includes, in addition to a detailed description of the new Brown-Mills aerophor rescue apparatus, an exhaustive treatment of the problem of the construction of vacuum storage vessels or containers for liquid air.

Liquid air was first used for mine rescue work in an apparatus known as "Aerolith," designed by an Austrian engineer, Herr Lüss, in 1906. This apparatus, which was not provided with a purifier or regenerator for absorbing the carbon dioxide in the exhaled air, failed to supply an adequate amount of air to the wearer when a heavy task was being performed, and consequently its use was strictly limited. In 1910 Col. Blackett invented a regenerative liquid-air apparatus bearing the name of "aerophor"; but it is this type of appliance in a modified and much improved form that has been installed recently in the Northumberland and Durham rescue stations.

The mode of action of the Brown-Mills aerophor, which is the most efficient and trustworthy of this type, will readily be understood by reference to Fig. 1, which is reproduced from the Report. It consists essentially of a "pack" P or liquid-air container, a regenerator or purifier Q, a breathing-bag M, and the necessary metallic and flexible tubes for conveying the gas from the "pack" to the bag and mouthpiece, and the exhaled air from the mouthpiece to the purifier. Liquid air is poured into the pack through a single central opening, and is absorbed by the calcined asbestos wool WW which is packed tightly in a perforated nickel silver case. The air space C which surrounds this case serves to distribute the liquid during the process of charging, and to collect the evaporated air. The latter passes through a pipe G into the space E, which is loosely packed with asbestos. From the upper side of E the gas flows into a metal warming-pipe H, and thence through the tubular spar A to the breathing-bag. During inhalation, air is drawn both from the bag and the purifier through the valve V_1. The exhaled air passes through the valve V_2 to the purifier Q, where the carbon dioxide is removed by caustic soda, and thence through valves V_3 and V_1 back to the mouthpiece. The space E, in addition to serving as an outlet for the evaporated air, impedes and to a limited degree regulates the flow of heat into the interior of the pack, and consequently controls the rate of evaporation. Immediately after charging the pack, the volume of cold air circulating in E, owing to the low specific heat of the liquid air, is very considerable, and consequently its insulating effect is a maximum. This results, at this stage, in a reduction in the amount of heat entering the inner chamber of the pack, and in a tendency to effect a diminution in the ebullition of gas, while towards the

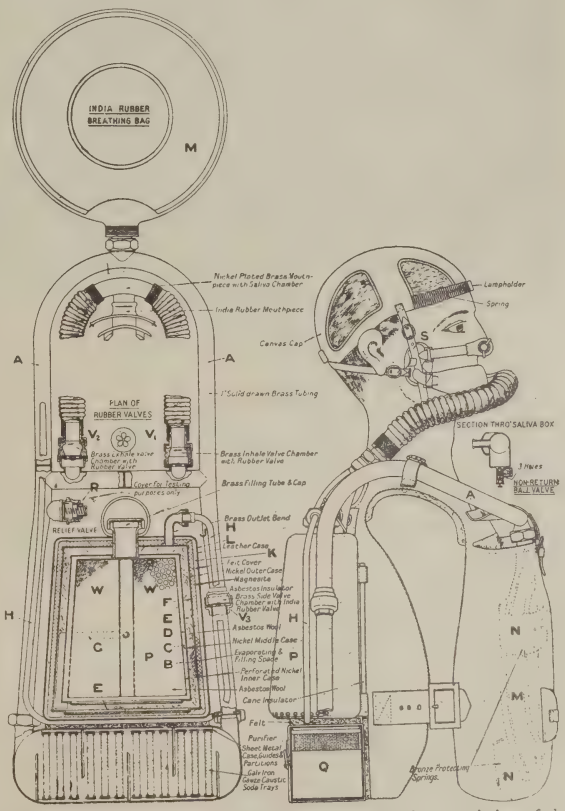

FIG. 1.—Brown and Mills aerophor. Reproduced, by permission of the Controller of H.M. Stationery Office, from the Third and Final Report of the Mine Rescue Apparatus Research Committee.

end of a "run," when the evaporation is flagging, it is stimulated by an increase in the amount of heat across that space. In spite of this automatic means of regulation the discharge is variable, being approximately 30 litres per minute just after charging, and falling off to 8 litres per minute at the end of the two hours' period. An important feature of the appliance is the valve V_3, which prevents the excess of air delivered from the pack during the first part of a run flowing in a reversed direction through the purifier, and thereby rendering the caustic soda comparatively inert by cooling. The pressure of the air in the breathing circuit is controlled by the relief valve R, which is set to operate at a pressure of about 18 lb. per square foot. The total weight of the apparatus, including the approved charge of $5\frac{1}{2}$ lb. of liquid air and 2 lb. of absorbent, is about 40 lb.

[1] Department of Scientific and Industrial Research: Advisory Council. Third and Final Report of the Mine Rescue Apparatus Research Committee. Pp. 32+32. (London: H.M. Stationery Office, 1924.) 1s. net.

The chief advantage claimed for the aerophor, and one that is recognised by the Research Committee, is its great simplicity in use. Compressed air appliances necessitate frequent adjustments, and occasional readings are required to be taken of the pressure-gauge. These are not necessary with the aerophor type of apparatus, and in consequence the wearer is free to devote the whole of his attention to the work in hand. Another obvious advantage is the continuous reduction in the load to be carried when in use, due to the ebullition of the charge.

FIG. 2.—Steel cradles for the transport of containers. Reproduced, by permission of the Controller of H.M. Stationery Office, from the Third and Final Report of the Mine Rescue Apparatus Research Committee.

All existing forms of liquid-air apparatus, with the exception of that designed by Mr. G. A. Griffiths, have one defect in common, namely, the evaporation of the liquid air when the apparatus is not being used. The chief obstacles, however, that militate against the general adoption of liquid air for mine rescue work are connected not so much with the apparatus as with the manufacture, storage, and transport of the liquid. As pointed out in the Report, the manufacturing plant, which is costly, requires skilled attention, and has to be run at intervals to make good the loss by evaporation in the reserve of liquid kept in storage flasks. These flasks, although giving little trouble during normal use at the rescue stations, are so delicately constructed that they require very careful handling when being transported at the surface or underground.

The movements of the flasks during a rail or road journey must of necessity increase the rate of evaporation of the liquid air. Experiments, including those which have been carried out under the auspices of the Research Committee by Dr. Briggs and Mr. G. L. Brown, show that under ordinary conditions the loss by evaporation during transport is nearly twice the loss that occurs when the flasks are stationary. With the view of determining the most efficient means of supporting liquid air flasks during transport, two flasks, each containing 50 lb. of air, were carried i heavy motor ambulance for a distance of 7·6 m over good roads. The first contain which was placed on the floor of car, lost 7 oz., whilst the second ves which was provided with trunni carried in spring-mounted bearin lost 14 oz. This unexpected result v due to the violent swinging of the ves on its trunnions by the movement the car, causing rapid ebullition of air and frequent spurting of the liq from the neck. As a result of this t the gimbal method of support has b entirely superseded by the simple st cradle (Fig. 2), a form of stand wh is giving remarkably efficient servi Storage flasks or containers form essential a part of the equipment liquid-air rescue stations that the Mi Rescue Research Committee is perfec justified in devoting considerable sp to them in its final Report.

The liquid air containers (Fig. are similar in every respect to "thermos" flask, except that th are made of brass or copper inste of glass, and that a small quant of specially prepared charcoal is serted in the vacuum space between the inner a outer vessels. Both vessels are constructed of t

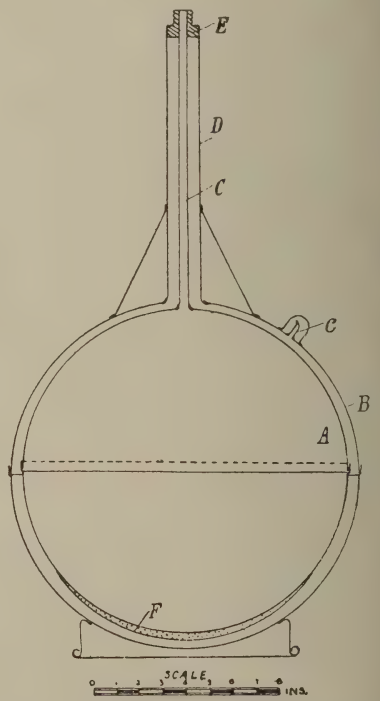

FIG. 3.—German 50-lb. liquid air container. Reproduced, by permiss of the Controller of H.M. Stationery Office, from the Third and Fi Report of the Mine Rescue Apparatus Research Committee.

hemispherical pressings, joined together by a s solder, the two necks C and D being soldered to plug E of solid drawn brass. A conical collar is fix

d the base of the neck for additional support. ir from the vacuum space is extracted through d tube G of about ¼-in. bore. When evacuation plete this lead is pressed flat, and is then burned ith a small Bunsen flame. The lead seal is pro- d by a cup-shaped cap filled with wax or bitumen. surfaces of the globes which face each other across acuum space are very highly polished to reduce ransmission of heat by radiation to the liquid air. e charcoal maintains the vacuum by absorbing as that leaks into the vacuous envelope through orous metals. The remarkable absorptive power harcoal at low temperatures, discovered by Sir s Dewar in 1905, has made possible the use of llic vacuum flasks and is contributing most to rapid expansion that is now taking place in the cation of liquid air and oxygen for industrial scientific purposes. Major Lambert found from periments he carried out for the Oxygen Research mittee that British palm-nut charcoal was capable bstracting the residual air from a vessel, which previously been partially exhausted, to such an nt as to reduce the pressure from 0·0575 mm. to ·00005 mm.

it be assumed that the pressure-reduction factor—ial pressure/final pressure—is directly proportional e amount of adsorbent used, then with the usual ge of 200 gm. of charcoal in a 50 lb. metal ainer, an initial pressure of 0·1 mm. in the vacuum e will be reduced to a final pressure approaching ·00002 mm., at the temperature of liquid air. At exceedingly low pressure the loss of heat by con- ion across the vacuum space is negligible in com- ason with the loss by radiation. For this reason it is not necessary to reduce the pressure in the envelope of a Dewar metal flask to the very low value required with the glass flask in the preliminary operation of pumping.

In order to determine the decay of the vacua of Dewar metal flasks, Dr. Briggs, a member of the Research Committee, has conducted a series of valuable experiments on 3-litre flasks. The apparatus used enabled the outer wall of a vessel to be punctured, the pressure inside the envelope to be measured, and the puncture sealed without damaging the flask or destroying the vacuum. These experiments showed the average rate of decay of the vacuum to be about 0·011 mm. per month. This slight, though continuous, deterioration of the vacuum, due to leakage of air through the excessively minute pores of the metal, necessitates periodical re-evacuation of the envelope, an operation which is performed at certain English rescue stations by the simple hand-driven Geryk pump.

Very interesting particulars concerning the cost of making liquid air have been supplied to the Research Committee by the chief English liquid-air stations. At Station A the 10-years-old plant was run for 477 hours, during which time 8705 lb. of liquid air was produced with a power consumption of 0·78 k.w.h. per lb. The cost, including power, repairs, chemicals, oil and water, but not including depreciation, establishment charges and labour, was 14·6*d.* per lb. At Station B, 8837 lb. was made in 440 hours with a power consumption of 1·17 k.w.h. per lb. The cost, including power, repairs, chemicals, oil and water, was 2·7*d.* per lb. Depreciation on the plant at 10 per cent. per year amounted to 4·3*d.*, and establishment charges to 4·2*d.* per lb., giving a total cost of 11·2*d.* per lb.

Obituary.

Dr. S. H. C. Martin, F.R.S.

SIDNEY MARTIN, the second son of the late John Ewers Martin, was born in Jamaica in 1860, and entered University College, London, in 1876, where he was a fellow-student and contemporary with Victor Horsley, Halliburton, and Frederick Mott. At this time many medical students at University College had a sure foundation for their subsequent medical studies by following an extended course of instruction in biology, chemistry and physics, and Martin was one of these. He took his degree in science at the University of London in 1878, being especially attracted to biology, largely owing to the stimulating influence of that inspiring teacher, Sir E. Ray Lankester. Afterwards, during his medical studies, he came under the influence of the late Sir John Burdon Sanderson, then Jodrell professor of physiology, who was not only a physiologist but also an experimental pathologist.

After graduating in medicine in 1883, Martin began working, at the instigation of Burdon Sanderson, as an investigator in the Jodrell Laboratory, then under the control of Prof. Schäfer, who had succeeded Sanderson on the latter's appointment to the chair of physiology at Oxford. This period of the early eighties was one of great activity in physiology and pathology in Great Britain, and Martin devoted himself to what was then a new field, namely, the investigation of the chemical side of vital processes, and more especially to an inquiry into the nature of the so-called toxic proteids. At this time the number of workers in this branch of knowledge was extremely limited, especially in Great Britain, and Martin carried out a series of researches not only on abrine and ricine but also during a number of years on the wider question of the nature and mode of action of the toxic substances elaborated by the activity of micro-organisms in infective diseases, more especially diphtheria, tetanus and enteric fever. He developed this subject in a long series of investigations recorded in his Goulstonian and Croonian lectures delivered before the College of Physicians in 1892 and 1898.

Although Martin's main work as an investigator was in the domain of chemical pathology, and he was one of the earliest workers in Great Britain on this subject, he was a recognised authority on pathology and pathological questions in the widest meaning of the terms. Thus he had an accurate and extensive knowledge of gross morbid anatomy and was professor of pathology at University College from 1895 to 1907 and the author of a text-book on pathology. Further, all his work, both as an investigator and as a teacher of pathology, was directed to the furtherance of clinical medicine and towards increasing the power of the physician to cope with disease, and Martin was a practising physician throughout his career. He was a teacher at University College and Hospital throughout

his life, from his appointment as assistant physician in 1891, to the time of his very sudden death whilst in active work. In addition to the posts he held in his old school, he had occupied numerous other appointments, as curator of the museum and pathologist to the Middlesex Hospital, pathologist and assistant physician to the City of London Hospital for Diseases of the Chest, and physician to the Hospital for Consumption, Brompton.

In 1895 Martin was elected F.R.S. and he served on the council in 1919–1921. He was elected F.R.C.P. in 1891, served on the council 1909 to 1911, was censor in 1915-1916, and gave the Lumleian lectures in 1915. He did a considerable amount of public work and was a member of the Royal Commission on Tuberculosis, in the work of which he took an active part. During the War he served on the staff of the 3rd London General Hospital, and was a member of the Committee of Reference that carried out important work in connexion with the provision of medical officers for service overseas. He was also a member of the Executive Committee of the Imperial Cancer Research Fund from its inception in 1902, and had recently been appointed chairman in succession to Sir William Church.

MR. F. H. BRADLEY, O.M.

IN Francis Herbert Bradley, who died on September 18 in a nursing home after a short illness, mainly the result of an accident, British philosophy has lost its most distinguished representative. Born in 1846, his life covered a period of unexampled activity in this department of thought, of which his may be said to have been the central influence. Himself profoundly influenced by Kant and Hegel, and having the advantage of the stimulus which the earlier expounders of their philosophy, notably Caird and Green, gave, his method and his achievements were entirely his own, and he stands out as one of the great line of Locke and Berkeley and Hume.

It is difficult in an obituary notice to indicate the ground of this claim. We have heard of a poets' poet. Bradley was a thinkers' thinker. He never lectured and was under no temptation to popularise his thought. On one occasion of controversy with a distinguished opponent, he complained of him that he lectured instead of writing philosophy. What gave Bradley a unique position among his contemporaries was, in the first place, the vigour and incisiveness with which he put an end to old ideas, and in the second place, the splendid lucidity of the statement, and the thoroughness in the detailed application of the ideas which he believed had to be put in their place.

It was thus in his "Ethical Studies," "the most readable work on serious philosophy in English," as it has been called, which appeared in 1876, that Bradley gave the *coup de grâce* to Hedonism, and in the celebrated chapter on "My Station and its Duties" provided the concrete foundation on which the best ethical thought of our time has since been content to build. Unfortunately, this book has long been out of print. Bradley had the intention at one time of reprinting it with notes and additions, as has recently been done with the "Principles of Logic," and it is greatly to be hoped that it will be found he had carried out part of this intention.

The "Logic," which appeared in 1883, occupies a similar place. On one hand, the theory which, as in Bain and Mill, attempted to found inference on the as ciation of ideas, is subjected to annihilating criticis on the other hand, for the old idea of the syllogism linear inference from isolated elements of identity, v substituted the idea of continuity with the orga system of experience as the principle of the forw movement of thought. The fertility of Bradley's w in these fields is familiar to students of philosophy the brilliancy with which the underlying ideas of " Principles of Logic " have been applied in logic Bosanquet, and in psychology by Prof. G. F. Stout.

It is, however, in his last great work on "Appearar and Reality" (1893) that Bradley's originality is m conspicuous. As in the previous books he had wag relentless war against abstract ideas in logic and ethi so here in metaphysics—or the search for ultim reality. The goal here is not to be found in any of t forms (space-time, quality, soul or self) in which phi sophers have sought it. Even the worlds of thoug and will give us only partial aspects of the compl experience which alone can satisfy. Taken in the selves they are the products of abstraction—*res ration* as Spinoza would have said. The ultimate reality something at once simpler and more complex. It simpler because it is something present with us all simple or again in exalted feeling; it is more compl because it must be conceived of as containing all t subtleties of difference and relation that science a philosophy find in it.

The dialectical form of this work, the deadly thru with which the claim of each category is transfixed, h given the impression, even to philosophers, that it mainly destructive. It has been called the *dis*appea ance of reality. What Bradley, on the contrary, w asserting was the growing fulness of the world in whi we live as we rise from the more abstract and mo obviously inadequate and relative forms of reality, su as space-time or matter, to the more concrete of huma personality and its life in art, morality, and religio Bradley was a relativist before Einstein. But h relativism differed from Einstein's in being univers and in being balanced and outweighed by his sense the necessity of presupposing an absolute as at once th criterion of the degree of relativity of any particular for of reality and the source of its significance and value.

Taken along with the volume of collected articl "Essays on Truth and Reality" (1914), and the not and "Terminal Essays" in the new edition of th "Principles of Logic" (1922), the essential constructiv ness of Bradley's work is unmistakable. But it is not b his contribution to idealistic philosophy alone that h influence on his generation has to be measured. It wa the clearness and uncompromisingness with which th main principle of idealism was stated in his chief work that, more than any other single influence, was th source of the violent reaction against it which marke the end of last century and the beginning of this unde the forms of pragmatism and the new realism. Th battle is still hot, and this is not the place to enter int the issues that are there being fought out. When on of the contributors to the recent volume on "Con temporary British Philosophy" suggested that i should be dedicated to F. H. Bradley as a tribute t "the chief," among the representatives of ever school, there was no dissentient voice except Bradley' own to forbid it.

J. H. MUIRHEAD.

MR. H. G. SMITH.

By the death on September 19, at Roseville, Sydney, New South Wales, of Mr. Henry George Smith, Australia loses one of her most eminent scientific men. Mr. Smith, who was born at Littlebourne, Kent, seventy-three years ago, was for many years assistant curator and economic chemist at the Sydney Technological Museum, and upon his retirement a few years ago he continued his researches in the Organic Chemistry Department of the University of Sydney. In collaboration with Mr. R. T. Baker, formerly curator of the Sydney Technological Museum, he carried out a series of investigations extending over thirty years which have thrown much light upon the scientific characteristics and economic possibilities of the essential oils and other products of the Australian flora. The main results of this work were published in two volumes entitled "A Research on the Eucalypts and their Essential Oils" and "A Research on the Resins of Australia." Mr. Smith was an unflagging worker, and his original papers, contributed to various scientific periodicals, number well over a hundred. Owing to the bulk of his work having been published exclusively in Australian journals, it received fuller recognition in Australia and America than in Great Britain.

Mr. Smith was an original member of the Australian National Research Council, and at various times he filled the offices of president of the Royal Society of New South Wales, president of the New South Wales branch of the Australian Chemical Institute (1922–23), and president of the chemistry section of the Australasian Association for the Advancement of Science. In the last-named capacity he delivered his presidential address on the chemistry of the Australian flora at Wellington, New Zealand, in 1923. He was an honorary member of many British and American scientific corporations, and was recently awarded the Syme Prize of the University of Melbourne as an appreciation of his services to scientific research in Australia. His character was marked by simplicity and sincerity, and he will be remembered as an outstanding pioneer of Australian chemistry.

WE regret to announce the following deaths:

Mr. J. E. Campbell, F.R.S., fellow and tutor of Hertford College, Oxford, and mathematical lecturer in University College, Oxford, on October 1, aged fifty-two.

Mr. Otto Hehner, president in 1891 of the Society of Public Analysts, on September 9, aged seventy-one.

Mr. J. Q. Rowett, who financed Shackleton's last expedition in the *Quest*, and provided funds for the establishment of the Rowett Institute of Research in Animal Nutrition in connexion with the University of Aberdeen and the North of Scotland College of Agriculture, on October 1, aged forty-nine.

Current Topics and Events.

AN important find of dinosaurian remains of Karroo age has recently been made a few miles west of the north-western shores of Lake Nyasa. The bones, including vertebræ, a scapula, and a coracoid, are on the whole in a good state of preservation, and it is hoped that many others will be found in the course of the more detailed examination of the area to be made in the near future. These are the first remains of the kind to be found in Nyasaland or elsewhere in this part of Africa; they have been identified by Dr. S. H. Haughton, of the Geological Survey of South Africa.

IN our issue of December 29, 1923, p. 925, we published an article commenting on the present system of distributing Government publications and their cost. In the issue of March 15, p. 407, we returned to the question, referring particularly to the question of price, and it was stated that the Library Association had made representations to the Treasury on the subject. As a result, public free libraries supported out of the rates, and the libraries of universities and university colleges in receipt of assistance from the University Grants Committee, were allowed to purchase Government publications at half-price. The matter also came before the Council of the British Association at the Toronto meeting (NATURE, August 9, p. 251). Dissatisfaction with present arrangements was further expressed at the annual conference of the Library Association held at Glasgow last month, when a unanimous resolution was passed instructing the Special Committee of the Association which has dealt with the matter to approach the Treasury again with the view of reducing considerably the present prices of Government publications and of establishing Depository Libraries in selected geographical areas." A Memorandum has therefore been drawn up setting forth the facts as to the costs of Government publications and asking that "the Government should recognise a comparatively small number (about 20) of the largest public libraries in selected geographical areas as 'Depository Libraries' where all Government publications could be freely consulted by the public *immediately* after publication." We hope that the Chancellor of the Exchequer will give the most careful consideration to the suggestions which the Library Association is making, and that some way of meeting the difficulties of the present position will be found.

IN our issue of January 12, p. 52, we published a criticism of the argument put forward in favour of the view that foot-and-mouth disease may be introduced into Great Britain by migratory birds. A similar question is raised by a paper by W. P. Taylor and H. C. Bryant on "Relation of Wild Birds to the Foot and Mouth Disease" (*California Fish and Game*, July 1924), in which the position is reviewed in relation to the conditions in Mercred County, California, mainly with regard to local spread rather than to introduction from a distance. The arguments for and against the bird theory are marshalled, the latter preponderating; but admittedly there is no proof, either positive or negative. We do not think that it has been seriously suggested in Great Britain that even if birds were proved responsible the remedy would lie in measures for their extermination, but here we read, under the heading "Psychological

Aspect," that in California this policy is strongly advocated by interested but ignorant parties. The writers even seem, at first sight, to make some concession to this view by devoting a section to the relative merits of different methods of destruction, not excluding poison gas; but this is perhaps mainly for the purpose of demonstrating the futility of all of them. They point out, for example, that shooting may lead to the wider dispersal of the surviving birds, and that officials charged with measures for the control of birds might become more dangerous potential carriers of infection than the birds themselves; only the killing of turkey buzzards which actually come to feed on diseased carcases is considered feasible. The writers conclude that any policy of destruction would be unjustifiable, impracticable, and useless—or worse. They might have added that any wholesale elimination of bird-life would probably deal an effective deathblow to all agriculture in the region.

THE Carnegie Institution of Washington, acting through its Advisory Committee in Seismology, and the Seismological Society of America, have agreed on certain methods to promote seismological research in both scientific and practical lines. The Advisory Committee was appointed four years ago, and decided to limit its work at first to the west coast region of the United States, where earth-movements occur in considerable variety. It has had the advantage of the co-operation of the Ukiah and Lick Observatories, the U.S. Coast and Geodetic Survey, the U.S. Geological Survey, and the U.S. Hydrographic Office, and can already point to some valuable results. The two observatories mentioned are continuing their observations of latitude in order to establish or disprove the northward crustal drift indicated by earlier observations. A fault-map of California has been published, and also a bathymetric chart of the continental shelf from San Francisco to Point Descanso, and a new primary triangulation has been made of the entire coast region south of San Francisco. The Seismological Society was founded in 1906, and its Bulletin, first published in 1911 and issued quarterly, has produced many useful memoirs. The agreement with the Advisory Committee provides that the latter shall bear the cost of printing specific articles which the Society could not otherwise undertake, and this enables the Society to issue an invitation to students of seismology and related subjects to use the Bulletin as a means of communication with their fellow-workers in other countries. The chairman of the Committee on Publication is Prof. S. D. Townley, Stanford University, California.

THE fifth annual report of the Tidal Institute of the University of Liverpool records an important administrative change: the Institute is now governed by a joint committee of the University and of the Mersey Docks and Harbour Board, one of the University representatives being nominated by the Admiralty. The same committee also governs the Bidston Observatory. The Liverpool Steamship Owners' Association has provided nearly all the fun required for the Institute during the past year a also for the coming year. The Institute is al making preparations for partial self-support by e gaging in commercial work on a comparatively e tensive scale. A special method of analysis and pr diction of tides suitable for large schemes of routi work has been devised; a tide-predicting machine also being constructed for the Institute, the co being defrayed by generous gifts from Liverpool shi owners. The machine, which is to be housed at t Bidston Observatory, is to be much larger than t Kelvin machines, and will incorporate new features design. The Institute will in future receive an i creasing share of Admiralty tidal work, and h already been responsible for tide-predictions for sev Colonial and three Japanese ports. The theoretic work of the Institute has been actively continu during the past year, particularly in relation meteorological effects on sea-level, and durir October, November, and December 1923, daily for casts of these effects on the sea-level at Liverpo were supplied to the Marine Surveyor of the Mers Docks and Harbour Board, in time to be of practic value as supplementing the information given in t regular tide tables.

THE belief has been expressed that the airsh industry will pass with the ZR3 from Germany the United States, where the Goodyear Tyre ar Rubber Co. has purchased all rights. On the oth hand, the experience gained in the design, constru tion, and test of the latest model will go far to tid Germany over the duration of the restrictions impos by treaty. Comparison with the first really successf Zeppelin shows the progress in design.

	Completed.	Volume ($m.^3$).	Total lift in tonnes.	Disposable load in tonnes.	Power (kw.).	Max. speed (km./hr.)
LZ3 .	1906	11,500	12·5	3·5	2×65	45
ZR3 .	1924	70,000	81	41	5×300	140

The following table gives the performance of 7 German naval airships:

Cause of writing off.	Number.	Av. life (months).	Av. service flights.
Enemy action . . .	24	6	15
Accidental fire . . .	12	7½	17
Weather and mishaps . .	22	7	12
Worn out	5	19	36
Dismantled after Armistice	9	16	21
Total . .	72		

Latterly, an airship coming within range of fightin aeroplanes met with almost certain destructior For commercial airship transport, eliminating wa and fire risks (on the assumption of adequate supplie of helium), and allowing for the effects of the Armistice a probable useful life of much less than 18 month and 32 voyages is indicated. The receipts woul clearly not pay capital and running costs without

ery subsidy. It will be of fundamental interest observe whether the ZR3 falls short of or improves these figures.

THE Public Works Branch of the Department of Industries and Labour of the Government of India has issued a second supplement to the Triennial Review of Irrigation in India 1918–1921 (issued in 1923), containing an account of State irrigation works carried out in the year 1922–3. From this we learn that, averaged over the plains of India, the rainfall was 5 per cent. above normal. The chief features of the distribution of the monsoon rainfall during the year were (1) the excess in the tract of country extending from the east and north Punjab to Orissa and Bengal, and (2) the deficiency over the Peninsula, excluding the west coast, and in the region of north-west India comprising the Rajputana desert and the country to the west. During the year 1922–23, the total area irrigated by all classes of works in India, excluding the Indian States, amounted to 81 million acres, which exceeds the average area irrigated during the preceding three years by about 2 million acres, and the record area of 28·1 million acres irrigated in 1919–20, by more than 180,000 acres. The largest irrigated area was in the Punjab, in which province $10\frac{3}{4}$ million acres were irrigated during the year. Next came the Madras Presidency with $7\frac{1}{8}$ million acres, followed by Sind with $3\frac{2}{3}$ million acres and the United Provinces with $2\frac{2}{3}$ million acres. The total capital outlay, direct and indirect, to the end of the year 1922–3 on irrigation and navigation works, including works under construction, amounted to Rs.84,57 lakhs, the gross revenue to Rs.10,06 lakhs, and the working expenses to Rs.3,85 lakhs. The net return on capital was, therefore, 7·3 per cent. From the crop returns, 13 per cent. of the total cropped area was irrigated by Government irrigation works, and the estimated value of the crops so irrigated amounted to nearly $1\frac{3}{4}$ times the total capital expended on the works, a very striking testimony to the value and efficiency of the latter.

THE September number of the *Scientific Monthly* contains an interesting article by Dr. Paul D. Foote, of the Bureau of Standards, on old and new alchemy. The old alchemists were of two types—the precursor of the modern "successful oil-stock promoters," and the persevering predecessors of the modern chemists. Mediæval alchemy was a logical consequence of the theory of Aristotle that all matter is composed of one primary matter, on which different forms could be impressed; modern alchemy is an equally logical consequence of the hypothesis that matter is composed of two primary substances, negative and positive electricity, the grouping of the particles of which, the electron and the proton, into different forms, is the study of the modern science of atomic structure. Dr. Foote describes the recent theories of matter and points out their bearing on the problem of the transmutation of the elements. The experiments of Rutherford on the disintegration of the nitrogen nucleus, for example, by α-rays, have to some extent removed the problem from the realms of pure speculation. The yields are still meagre: if all the four and a half billion billion α-particles from 1 gram of radium and its products in one year were projected into an aluminium target, the hydrogen liberated by the disruption of the nuclei would occupy 1/1000 cubic millimetre.

A FULL report of the conference held in July last to consider the most effective means of securing the adoption of decimal coinage and the metric system appears in the September issue of the *Decimal Educator*, published by the Decimal Association. Representatives were present from Great Britain, the Dominions Overseas, and the United States, and it was resolved to urge the Government to appoint a committee to consider the advisability of making the penny one-tenth of the shilling, and to get rid of the confusion introduced into the measurement of volume by the change from the wine gallon to the Imperial gallon in Great Britain a century ago, without consultation with America. The conference suggested that the two gallons now in use should, by co-operation with America, be made identical and equal to four litres, so that the quart would be exactly a litre.

AN account is given in *The World's Health* for August (the organ of the League of Red Cross Societies) of the Papworth (Cambridge) village settlement for tuberculosis by the Director, Dr. Varrier-Jones. The colony numbers 196 persons. Patients are admitted in all stages of the disease, and the work they do is graduated according to their capacity. There is no limit to their length of residence, and they are encouraged to settle permanently with their families. It is thus possible for patients whose working capacity is below normal to continue doing part-time work for many years, instead of having to give up entirely in competition with the outside world. Dr. Varrier-Jones holds that this procedure prolongs life and renders it happy and useful, as well as being a sound business proposition.

THE Minister of Health has appointed the following committee to deal with the question of the supply of morphine and heroin to drug addicts: Sir Humphry D. Rolleston, Bt. (chairman); Sir William H. Willcox; Mr. J. W. Bone; Dr. R. W. Branthwaite; Dr. G. M. Cullen; Prof. W. E. Dixon; Dr. J. Fawcett; Mr. A. Fulton; Mr. J. Smith Whitaker. The committee is "to consider and advise as to the circumstances, if any, in which the supply of morphine and heroin (including preparations containing morphine and heroin) to persons suffering from addiction to those drugs may be regarded as medically advisable, and as to the precautions which it is desirable that medical practitioners, administering or prescribing morphine or heroin, should adopt for the avoidance of abuse, and to suggest any administrative measures that seem expedient for securing observance of such precautions." The joint secretaries of the committee are Dr. E. W. Adams and Mr. R. H. Crooke, Ministry of Health, Whitehall, S.W.1, to whom all communications should be addressed.

IN addition to the awards of the Institution of Civil Engineers for papers announced in NATURE of October 4, p. 513, the Council has awarded a Telford Premium

to Prof. Louis N. G. Filon (London) and an Indian Premium to Mr. F. C. Temple (Jamshedpur, India).

THE Institute of Metals programme for the session 1924–25 covers the work not only of the parent Institute, but also of its six branches located in various metallurgical centres. More than thirty lectures dealing with various phases of non-ferrous metallurgy are enumerated in the programme. Prof. H. A. Lorentz is to deliver the annual May lecture. Copies of the programme can be obtained from the secretary of the Institute, Mr. G. Shaw Scott, 36-38 Victoria Street, Westminster.

AN attractive list of free popular lectures to be delivered on Saturday afternoons at the Horniman Museum, Forest Hill, has just been issued. The lecture hour is 3.30, beginning on October 11, and the subjects of the lectures are "The Development of Modern Radio Communication," "Cornish Scenery and its Causes," "Social Life among Insects," "Some Famous Pharaohs," "The Amulets of Ancient Egypt and of Modern London," "Evolution and Darwinism," "Prehistoric Man and the Land of Lyonesse," "The Eggs of Animals," and "The Glory that was Thebes." No tickets will be required.

THE Chadwick Public Lecture programme for this autumn includes lectures in London on "Defective Hygiene and Child-Life," with special reference to the effect produced on growth and development of children by town dwelling and slum areas, by Dr. Lawson Dick; "Rats," by Mr. Mark Hovell; "Smoke," with a review of its causes, its effects on vegetation, fabrics, masonry and metal work, and its influence on health and the death-rate, by Prof. J. B. Cohen; and "Ante-Natal and Post-Natal Child Physiology and Hygiene," by Dr. W. M. Feldman. Further information about these lectures can be obtained the secretary of the Chadwick Trust, Mrs. Aubr Richardson, at 13 Great George Street, Westminst

MESSRS. J. and A. Churchill announce for public tion early next year a "Dictionary of Perfumery by E. J. Parry, which will deal with the raw materia of the perfumery trade and with allied subjects fro the points of view of the chemist, the manufacturer a the user. The work, which will be in two volume will contain special signed contributions by Messrs. A. Marrin, C. T. Bennett, T. H. Durrans, M. Dewhirs A. Garden, M. Salamon, and W. H. Simmons.

MESSRS. Thomas Murby and Co. are publishi shortly "A Handbook of the Geology of Ireland by the late Prof. G. A. J. Cole and T. Hallissy, whi is based on Prof. Cole's contributions to "T Handbook of Regional Geology," a German public tion. Another work in the same publishers' list announcements is "Useful Aspects of Geology," Prof. A. J. Shand, which aims at giving an account the various ways in which a knowledge of geolo can be turned to use, and at showing where to go f fuller information on each particular subject.

MESSRS. Ernest Benn, Ltd., announce for ear publication, under the title "Science and Labour the principal papers read at the Conference Science and Labour at the British Empire Exhibitio in May last. The subjects dealt with include T Place of Science in Government; Scientific Researc in Relation to Industry; The Co-operation of Scien and Labour in Production; Science and the Huma Factor, and Science in Educational Organisatio Among the contributors are Lord Askwith, Sir Richar Glazebrook, Sir Richard Gregory, Mr. Hugo Hirs Sir Thomas Holland, Sir Oliver Lodge, Sir Arth Newsholme, and Mr. Sidney Webb.

Our Astronomical Column.

THE TOTAL SOLAR ECLIPSE OF JANUARY 24, 1925.—The Journal of the R.A.S. of Canada for August–September 1924 contains an interesting article on this eclipse by R. M. Motherwell, of the Dominion Observatory, Ottawa, illustrated by a map of the track over Canada and the United States.

The eclipse comes at a bad season of the year, with a rather low sun, and the weather prospects are poor; but it is visible in a very populous region, including the observatories of the University of Toronto, of Columbia University, and of Vassar College, so that the most is likely to be made of the occasion. Portions of all the great lakes lie within the zone of totality; Niagara and Buffalo are near the central line. New York is just outside the southern boundary.

Totality lasts nearly two minutes on the central line. A large partial eclipse is visible throughout the British Isles. In the Western Hebrides the solar crescent left uncovered will be only some 8″ in width, but the sun will be too low there for any useful work.

This eclipse is a recurrence after the triple Saros of that of December 1870 visible in South Spain, North Africa, and Sicily. It was interesting from Prof. Young's discovery of the reversing layer, and the beautiful coronal photographs obtained by Mr. Brothers.

PROF. LA ROSA'S THEORY ON THE CAUSE OF STELLAR VARIABILITY.—Prof. La Rosa's suggestion that stellar variability may be explained on the ballistic theory of light was recently noticed in this column. The theor supposes that light follows the law of projectiles, th total velocity being compounded of the velocity of th source and that of light, so that in the case of distant star revolving in an orbit, the light that leav the star in equal time intervals arrives in unequa intervals, thus causing an apparent light-variation.

Prof. de Sitter criticises the theory in Bull. Astro Instit. Netherlands, vol. ii. No. 57, on the ground tha since the number of waves of any definite length tha enter the eye per second would be altered in the sam ratio as the light-intensity, an enormous Dopple shift, far beyond any actually observed, would resu if the theory were true.

Prof. La Rosa replies to this criticism in *Astr. Nach* No. 5319. He notes that his theory is not really wave-theory but a corpuscular or "quantum" one Still it is convenient to use the language of the wave theory. The point he lays stress on is that th spectral shift observed does not depend on the numbe of waves that enter the eye per second, but on th distance between crest and crest of these waves, an this distance would depend on the actual velocity o the star in the line of sight.

Probably most astronomers will consider that Pro La Rosa's theory is difficult of acceptance on othe grounds (notably the Michelson-Morley experiment) but that possibly the particular objection raised b Prof. de Sitter is not decisive.

Research Items.

A Congo Fetish.—Mr. H. V. Hall figures and scribes in a recent issue of the *Museum Journal* one e interesting and important wooden statuettes monly known as "nail fetishes" from Loango, coast district north of the Congo. The figure, t 32 inches high, represents a man standing with eft hand resting on the hip, the right raised as if to v a spear or inflict a blow with a bush knife. The of the head is left unfinished. It was formerly ed with a cap of hardened paste. Such caps were ste of varied composition, but usually containing nous elements. This paste embodied the fetish or power. It was sometimes attached in the of a casket to the abdomen or chest. These nes are said to have been employed when other s of detecting crime, such as the ordeal by poison, failed. In the course of a divinatory ceremony, power of the fetish is loosed against the offender by iring of a gun; but for certain offences a nail, times heated, is driven into the figure. It is also e in taking an oath in a solemn engagement; both nes strike a blow or two on the same nail, while each res the fetish to eat him up if he breaks his vow.

The Aborigines of Tasmania.—In the first R. M. uston Memorial Lecture delivered to the Royal ety of Tasmania last session, Sir T. W. Edgeworth id gives a useful summary of the geological ence of the antiquity of man in the Australian monwealth, with special reference to the Tas- ian aborigines (Proc. Roy. Soc. Tasmania, 1923). also records some new observations on the occur- e of stone implements, much resembling the er palæoliths of Europe, in the superficial deposits asmania. These implements have been found not in river drifts and lake beds of great antiquity, also in raised beaches from three to five feet above present sea level. Indeed, considering all the ence, "if aboriginal man in Tasmania was really emporaneous with one of the last great ice ages, he t have witnessed a sea level perhaps no less than feet lower than it is at present." He must have sed Bass Strait when it was either dry land or a narrow strip of sea; and as the dingo did reach Tasmania, the date of this crossing must e been anterior to the arrival of the Australian riginal in southern Australia. Implements have not e been discovered in Tasmania in association with remains of the large extinct marsupials, and Sir geworth David suggests that special search should made in the older sand dunes such as those of g Island, where remains of Nototherium have been d. He also thinks that further explorations are rable in the peat deposits and caves. Excava- as for harbour works and dredgings in Bass Strait uld be specially watched. Evidence of several ances and retreats of the ice during the glacial iod has already been noted in Tasmania, and there ns to be some hope that these may eventually be related with similar fluctuations in the northern isphere.

Scottish Anthropometry.—Every fresh analysis the anthropometrical characters of the people of tland emphasises the impossibility of discovering ial traits of any significance in a general sample of population. Since the first invaders made their tlements, fresh waves of immigration from outside l movements within the boundaries have tended to mp the original distinctiveness of the races. The neral population has become too mixed to be signifi- nt, so that the anthropologist must now rely only on chance of finding in certain localities pockets of individuals, who through a modified geographical isolation, or through a more effective isolation due to a persistent habit of intermarriage, have retained some indications of their origin. For this reason special value attaches to a small "Illustrated Catalogue of Specimens from Prehistoric Interments found in the North-east of Scotland," and contained in the Anthropological Museum at Marischal College, University of Aberdeen, of which Prof. R. W. Reid was the originator. The work, compiled with great care by Prof. Reid and his colleagues, contains an analysis of the human remains contained in some score of short stone-cists, along with descriptions of the beakers and other objects associated with the burials. The restricted area from which the interments have been drawn allows of easy comparison with the present-day population in the same district, which has recently been shown, by Dr. Tocher's researches, to be outstanding amongst the peoples of the Scottish mainland on account of the large proportion of brachycephalic individuals it contains. The Catalogue shows that the earliest settlers who have left traces of their habitation in the north-east of Scotland were markedly brachycephalic, with a brain-capacity similar to that of the average modern Scot, but of considerably smaller stature. They probably belonged to the broad-headed Alpine race which overflowed western Europe from the east during the Bronze Age. One notable exception is catalogued, a brachycephalic individual found at Catterline in Kincardineshire in 1923, whose brain-capacity was considerably greater than the modern average, 60 c.c. greater even than that of the large-headed Robert the Bruce, and whose stature was approximately 5 feet 8 inches. To this 3000 to 4000 years old race, or to subsequent immigrations from its continental settlements, may be attributed the predominant broad-headedness of the modern inhabitants of Aberdeenshire and the surrounding counties.

Protecting Wood against Termites.—Termites are particularly destructive to untreated wood in any form both in the United States and the tropics. Bulletin 1231 of the U.S. Dept. of Agriculture, by Mr. T. E. Snyder, is devoted to an account of tests of methods of protecting woods against the ravages of these insects. These experiments were conducted between 1912 and 1922, while supplementary data were obtained from inspections of treated timbers made from 1909 to 1922. The most effective preservative in protecting timber to be set into the ground was found to be coal-tar creosote. Impregnation by the "open-tank" method renders wood resistant to termite attack for at least 15 years. Impregnation by the full-cell process enables wood to resist these insects for at least 25 years, and this method is recommended for use in tropical countries. Brushing the creosote, in several coats, on timber will add from 2 to 5 years to its life. For interior woodwork, furniture, cabinet woods, etc., impregnation with zinc chloride, bichloride of mercury, sodium fluoride or chlorinated naphthalene is effective. Another protective method is to treat the hidden cheaper cores of furniture, cabinet woods, etc., with preservatives during manufacture, and then overlay them with veneers of termite-resistant woods. No species of tree apparently has wood which is absolutely resistant to termites, but among the most resistant woods are the teak and sal of India—a fact well known in that country; cypress-pine and camphor-wood of the Orient; greenheart of South America; redwood, western red cedar or giant arborvitæ, incense cedar, Port Orford cedar, yellow cypress, and species of

juniper of the United States. Wood-pulp products were also used in the tests and consisted of processed boards utilised in interior finish and as substitutes for lath, tiling, etc. These products were found to stand the tests best when crude carbolic acid or coal-tar creosote were added to them, although the odours are a disadvantage. It is stated that a large market for both crude and finished forest products could be found by American manufacturers in South America, and other tropical lands, provided satisfactory termite-proof products could be furnished.

PERMEABILITY OF LEAF CELLS.—Prof. H. H. Dixon describes a new method for determining the changes in the electrical conductivity of leaf cells, in Notes from the Botany School, Trinity College, Dublin, iii., 1924, 272 (see also Proc. Roy. Dublin Soc. xvii., No. 45, 1924). The method consists of placing a cut square of leaf on the horizontal arms of two plate electrodes, the latter being moistened with sap expressed from the leaf. It is found that temperature affects the permeability of leaf cells considerably, a rise of 10° C. increasing the conductivity (on an average) to 1·33 times as much. Further, changes of temperature of the order of 10° C. are shown to occur readily in insolated leaves, and hence considerable changes in permeability may be produced in a short time, which have doubtless an important bearing on the movement of materials in the leaf.

CARBON ASSIMILATION IN CONIFERS.—An interesting study of the ecology of carbon assimilation has been made by M. G. Stålfelt (Meddel. fr. Statens Skogsförsökanstalt, 21, 1924, p. 182). This deals with the rate of carbon assimilation of pine and spruce leaves in relation to temperature, light intensity, and the carbon dioxide content of the air. The measurements were carried out under natural conditions. The rate of assimilation falls off very markedly in older leaves at the higher light intensities, but in light intensities of about 30 per cent. of full sunlight, leaves of five years of age absorb much more carbon dioxide per hour than do young leaves (a year old). There is little or no assimilation below about 5 per cent. of full sunlight. The chlorophyll content of the leaves was also determined. For *Pinus sylvestris* the average was 15 mgm. and for *Picea excelsa* 10·6 mgm. in 10 gm. of fresh leaves. The numerous data might possibly repay further analysis. The author discusses xeromorphy in conifers in the light of his findings. A résumé in German is given.

THE STRUCTURE OF THE BASQUE PYRENEES.—In the *Boletin de la Sociedad Iberica de Ciencias Naturales* for 1923, Mr. P. W. Stuart-Menteath vigorously assails the recent work of the French geologists who have been engaged in revising the geological maps of the Pyrenees. While the official interpretation of the structure invokes thrusting on a large scale, Mr. Stuart-Menteath asserts that in the neighbourhood of the old mine of San-Narciso—a region that he has studied in great detail for many years—there is no evidence whatsoever of a thrust plane or of an abnormal sequence. Such evidence as has been put forward in support of the overthrust hypothesis is, according to this observer, due to a complete misreading of the stratigraphy. A formation, for example, that has been mapped as Carboniferous he claims as Flysch; and the underlying "mylonites" are, he says, ordinary conglomerates which locally contain Cenomanian fossils attached to pebbles of ophite. Collaborating with M. E. Fournier in the *Bull. de la Soc. Geol. de France*, xxiii. p. 102, 1923, detailed evidence is presented of the straightforward succession in and around the mine of San-Narciso. The mine itself has been abandoned and filled with wa for thirty years; but, despite this obstacle to obser tion, a band of limestone occurring beneath undoub Palæozoic rocks in the lower levels of the mine been considered as Cretaceous, and therefore as affo ing sufficient proof of an overthrust to bring controversy finally to an end. The authors, howev maintain their old view, based on actual investigati of the mine itself before it was closed down, that t limestone in question is of Devonian age, and that is normally surmounted by Carboniferous and Tri which in turn in a neighbouring syncline is follow by Cretaceous. It is to be hoped that the Fren geologists whose maps so flagrantly contradict t work of Mr. Stuart-Menteath will now discuss t evidence which has led them to disregard observations and conclusions.

HOURLY RAINFALL IN UNITED STATES.—T *Monthly Weather Review* for April has two articles variations in hourly rainfall at different places about the centre of North America which are co firmatory of each other. The first article, for Lincol Nebr., is by Mr. H. G. Carter, Meteorologist at t Weather Bureau. At Lincoln there is twice as mu rain in May as in October, and May has 50 per ce more hours with rain than October, but the avera shower in October lasts 25 minutes longer than t average shower in May. The data used in the pap cover 19 years, 1905–1923, and are for the months May to October only. For the entire period, abo 34 per cent. of the total amount falls during t twelve hours from 6 A.M. to 6 P.M., and about 66 p cent. from 6 P.M. to 6 A.M. In August 74 per cent. precipitation occurs during the night hours, while October the night precipitation is 53 per cent. a the day 47 per cent. The greatest rain frequen occurs in May, the least in August. The seco article deals with hourly precipitation at Topek Kans., and is by Mr. S. D. Flora, Meteorologist the Weather Bureau. Three-fourths of the pr cipitation falls in the six summer months and largely the result of thunderstorms. The hour wi the heaviest fall of moisture is near sunrise, and t hour with the least from noon to 1 P.M. The avera fall of rain at Topeka from 5 A.M. to 6 A.M. is mo than three times as great as from noon to 1 P.M more than 60 per cent. of the average day's precipit tion occurs between 6 P.M. and 6 A.M. The resul obtained will be welcomed by those interested rain insurance and by many others; some of t conditions which control the results would doubtle be similar to the conditions in Europe.

WINDS OF CENTRAL EUROPE.—Dr. Albert Defan of the Institute of Cosmical Physics of the Universit of Innsbruck, contributes an appendix (just issued) t the 1920 Yearbook of the Central Office for Meteor logy and Geodynamics, Vienna. The appendix co sists of a discussion of certain characteristics of th distribution of wind over the area which, before th War, was subject to the Austro-Hungarian monarch The data are derived from 372 wind-stations—236 Austria, 113 in Hungary, and 23 in Bosnia-Herzeg vina—and in most cases observations from ten yea are used; a list of the places and dates is given. Th collection of the data was undertaken during the Wa for war purposes. For each station the wind-observa tions for each of the twelve calendar months, at th separate hours 7 A.M., 2 P.M., and 9 P.M., were classifie according to the direction of the wind (8 compas points being used) and according to the intensity (i five classes). The summaries for the frontier regio were reproduced lithographically during the War, bu otherwise the data have remained unused. Th

pendix now summarises the data for the two months January and July (taken as typical of winter and summer) by means of eighteen maps showing by isopleths the distribution of various wind-characteristics. Six maps show the lines of equal frequency of (*a*) calms or light winds, (*b*) moderate winds, and (*c*) strong winds, for the two separate months, combining the results from the above three hours. Four maps show lines giving at each point the vectorial mean wind-direction for the separate hours 7 A.M. and 2 P.M. in January and July; four others show the lines of equal vectorial mean wind-velocity v for the corresponding times. Two maps give the lines of equal mean wind-velocity V, averaged without regard to direction, for the two months separately, combining the results for the three hours; while the last two maps indicate the value of the ratio v/V, which is evidently a measure of the constancy of direction of the wind at each place. It is impossible to describe these various maps briefly, but as regards wind-direction, they show that the wind is mainly westerly, though, particularly in the mountain regions, there are certain interesting disturbances of this general current.

The Ranges of the α-Rays from Uranium I and Uranium II.—Wölsendorf fluorspar shows pleochroitic haloes, due to the action of the α-rays from minute specks of radioactive substances. The phenomena are described by Dr. B. Gudden in the *Zeitschrift für Physik* of August 8. The haloes differ from those seen in mica, owing to the fact that fluorspar is bleached by rapid α-particles, and it is only at the end of the range that this action is reversed, and the material is coloured by their action. A section through the radioactive particle shows a series of fine circular zones corresponding to the different radioactive substances which have sent out α-rays. Measurements with different specimens show the haloes of uranium and uranium II (as a rather broad line), ionium, radium, polonium, radium emanation, radium A, and radium C^1. Although the haloes of uranium I and uranium II are not separated, it is possible from the measurements to determine the ranges in air of the particles from these substances, with an uncertainty of less than one per cent. The values obtained, 2·68 and 2·76 cm., are 1·5 mm. greater in the case of uranium I and 1·5 mm. smaller for uranium II than those previously regarded as correct. They show that the small values of the disintegration constant, λ, there are large variations from the linear relationship between log λ and log R_0, and they make the mean life of uranium II about fifty times as long as was previously suspected.

Electric Arcs with Non-Incandescent Cathodes.—Messrs. Stark and Casuto, using a brass anode rotated under the anode and so kept cool, were unable to maintain an arc; but Dr. H. Stolt describes experiments in the *Zeitschrift für Physik* of August 8 which show that if the disc is well polished, an arc can be produced. Still better results were obtained with cathodes of copper, silver, and gold, but there was no success with aluminium. The anode was a 0·3 cm. rod cut off at right angles to the axis, or with a little slope, and was held in a spring holder near the outer edge of the disc. The arc was struck by pressing the anode towards the rotating cathode against the spring, and at once releasing it. With small currents the disc could be touched with the finger at a point where the arc was in existence 1/100 sec. previously; and even with 10 amperes the temperature here does not appear to exceed 200° C. Spectroscopic examination of the arc throughout its length also showed no incandescence at the cathode. Very similar results were obtained by Nicol, who caused an arc to rotate between ring electrodes of copper in a radial magnetic field. Child and Bräuer assume that electrons are produced at the cathode by collisions of positive ions, but consider that a high temperature is necessary; apparently, however, this is not the case.

Influence of Magnetic Fields on Phosphorescence.—When an excited phosphore is heated, illuminated with light which does not excite it, or placed in a strong electric field, the rate at which it gives off light is increased, and the time during which it remains phosphorescent is diminished. In the *Annalen der Physik* for September, Dr. E. Rupp shows that similar results are obtained in a strong magnetic field; though the smallest field which gives a visible result is 17,200 gauss, using Zn Cu_α five minutes after excitation. The largest field available was 45,000 gauss, since larger currents could not be used in the magnet employed. Even with this field the effect was smaller than that produced with an electrostatic field of 10,000 volts per cm., and it is possible to employ very much larger electric fields than this. Thus it was not possible to observe all the phenomena obtained with electric fields by using magnetic fields, though the phosphore flashed brightly when the current was switched on, and this can be repeated once or twice, though with diminishing intensity. The extra light in the flash from a phosphore was found to be partly polarised perpendicular to the magnetic lines of force. This is more distinct with zinc manganese phosphores than with zinc copper phosphores, and there is no such phenomenon in an electrical field. F. Schmidt has explained the electrical phenomenon as being due to an alteration in the movement of the electrons, and to a rotation of the polarised atom pairs; the same explanation seems to hold for the magnetic action, since an electric field $E = vH$ is produced when magnetic lines of force pass through a space with velocity v. The polarisation of the light given off in this case seems to indicate that, in addition to this, the emission from the phosphorescent centres is directly influenced by the magnetic field, the orbits of the electrons being affected as in the Zeeman effect. The different atomic magnetism of the elements involved may also be of importance.

Rotatory Dispersion.—In the August number of the Journal of the Chemical Society, Lowry and Richards describe some measurements of the rotatory dispersions of octyl alcohol and octyl oxalate. A large number of wave-lengths was used in each case and the measurements were carried out with the greatest care. The results showed that the rotatory dispersion of octyl alcohol can be expressed completely by one term of Drude's equation. In the case of the ester, the results approximated to the inverse-square law of Biot, but could not be expressed either by that law or by one term of Drude's equation. The dispersion is therefore not simple, but complex.

The Production of Diamonds.—In the April-July number of the *Compte rendu des séances de la Société de Physique*, of Geneva, Duparc and Kovaleff describe an experiment in which carbon disulphide and "a metal easily sulphurised" were compressed to 8000 atm. for fifteen minutes. When the metal cylinder was dissolved in an acid a small residue, transparent, colourless, or slightly yellow, of irregular form, and capable of scratching glass, was found. It was birefringent and had a high index of refraction, but no density measurements were made. After a few days the residue fell to a powder. It is assumed that the region of stability of diamond at the ordinary temperature commences at a pressure below 8000 atm.

Ferrous Alloys Research: The Iron-Oxygen Equilibrium.

AT the autumn meeting of the Iron and Steel Institute held in September at the British Empire Exhibition, Wembley, an account was given by Dr. Rosenhain and some of his colleagues of an investigation of the alloys of iron which was begun by them rather more than a year ago under the auspices of the Ferrous Alloys Research Committee, which is the successor of the Alloys Research Committee of the Institution of Mechanical Engineers. The new Committee contains representatives of the Royal Society, the Institutions of Civil Engineers, Mechanical Engineers, Electrical Engineers, Naval Architects, and Mining and Metallurgy, and the Iron and Steel Institute. Under the auspices of this Committee, and with the concurrence of the Advisory Council of the Department of Scientific and Industrial Research, a beginning has been made upon a programme of work which is more ambitious, more difficult, and more expensive than anything which has hitherto been attempted. As Dr. Rosenhain points out in his introduction (Part I.) to the research, in spite of the large amount of scientific research devoted to the alloys of iron, much fundamental knowledge as to the constitution of the binary systems is still lacking. Most of the alloys hitherto investigated contain some carbon in addition to the special alloying metal, and this may, and probably does, have a profound influence on the equilibrium in question. Many of the most important industrial alloys contain three or more elements, and their composition has been arrived at largely by empirical methods. The precise influence of any particular element is largely a matter of guess-work. For this reason it is eminently desirable that the equilibria of the binary systems should be determined with the purest materials and the highest accuracy possible.

Messrs. Tritton and Hanson are responsible for Part II. of the research, which deals with the equilibrium of iron and oxygen, and a brief survey of their experiments will show something of the difficulties encountered in investigations complying with the above-mentioned standard. The iron was prepared by the method of Cain, Schramm, and Cleaves from an electrolyte containing pure ferrous chloride and sodium chloride. The product was satisfactorily pure except for a rather high oxygen content, due, so the authors think, to the formation of rust in the iron, which was deposited in a slightly porous form. Special attempts were made to prepare iron free from oxygen. At a later stage of the investigation a high-frequency Ajax-Northrup induction furnace became available, and the authors melted electrolytic iron previously purified by heating in hydrogen to 1200° C. in a vacuum of about 2 mm. of mercury, but the metal was not free from oxide. After various attempts, the best method was found to be to blow purified hydrogen on the surface of the metal during melting and for a period of fifteen minutes when molten. Even then the resulting metal was found to contain an amount of oxide estimated to represent about 0·08 per cent. oxygen. Both china clay and magnesia pots were used. It is to be gathered from the authors' paper that no iron prepared by them contained less than the above-mentioned amount of oxygen.

One of the greatest difficulties was to obtain pots and other refractory articles suitable for the work. Those made either of silica, china clay, or alundum will not hold molten iron containing much oxide for more than a few minutes, owing to the rapid attack on the pot by the oxide. Special pots had theref to be manufactured at the laboratory, and a u method has been developed, involving direct fus of the refractory in an electric arc, for producing p having internally glazed surfaces of great resista to chemical attack. The refractory (previou melted and powdered) is placed in a suitable recepta and spun in an electric arc in such a way as to fo in a few minutes a well-shaped pot having a body highly fired material, the internal surface of wh has been completely molten, leaving a glazed surf on the interior of the pot. Only in these was it fou possible to hold molten iron and iron oxide at t same time. For low-oxygen melts, china clay p were used, while for the higher oxygen alloys, bond pots of fused magnesia were found best.

Another difficulty which had to be overcome w

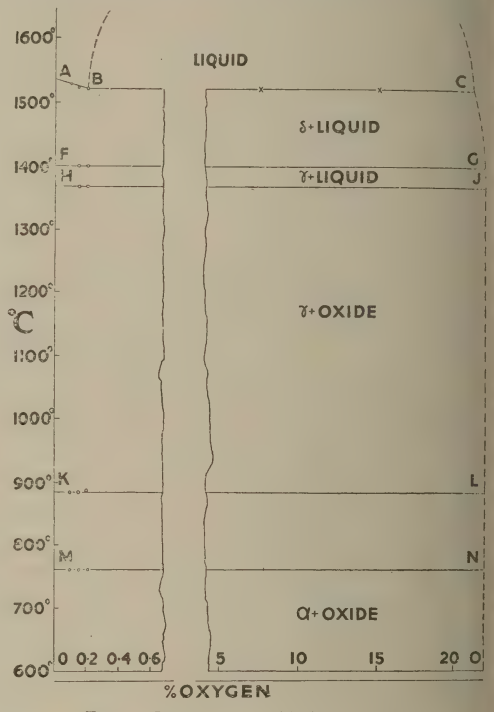

FIG. 1.—Iron-oxygen equilibrium diagram.

the contamination of the thermocouples, due appa ently to the penetration of the couple protector t the iron vapour. The best method was found to i to use a very low-sided pot and to blow nitrog across the surface of the melt. Contaminatio was worse in the pure platinum wire than in th platinum 10 per cent. rhodium alloy. According the authors substituted thermocouples of wires co taining 5 per cent. and 20 per cent. of rhodiu which gave a sufficient sensitivity for thermocoup work.

In spite of these improvements a certain amount contamination always occurred, so that the coup needed frequent testing and the removal of the co taminated portions of the wire. The freezing-poi of iron of the lowest oxygen content was found to 1535° C. referred to 1555° C. as the melting-point palladium. This is probably a very close approac to the freezing-point of pure iron, since, in spite the presence of oxygen, the slight slope of the liquid

re of the iron-oxygen diagram indicates that the ft of this amount of oxygen must be small. The e ng-point of the oxide stable at these tempera- r was found to be 1370° C., and that of the δ t ge point in iron 1407° C.

The authors have given the iron-oxygen equilibrium ram between 0·1 per cent. and 22 per cent. of ygen, represented by the compound FeO. This ram, which is reproduced in Fig. 1, is of con- rable interest. It shows that the percentage of ygen dissolved by iron in the liquid state does not ed 0·21 per cent., and that above this the liquid rates into two melts. The lowering of the ing-point of iron is, in fact, only about 8°. The l solubility of oxygen has not been exactly deter- ed, but is estimated to be about 0·05 per cent. will be seen from the diagram that oxygen is tically without effect on the δ, γ, and α change ts.

The authors have been able to prepare ingots ure iron-oxygen alloys, to roll them, and to sub- them to various physical tests. The maxi- m weight of ingot was about 450 gm. They e found that the low-oxygen iron (0·08 per cent.) be rolled perfectly easily both hot and cold, and the rolled material is ductile in a tensile test. ts, however, very brittle under notched bar impact tests; this may be due to the large grain size of the material which is facilitated by the purity of the metal in other respects. Ordinary normalising methods do not produce a small grain size in low-oxygen iron. With increasing oxide content there is a marked decrease in ductility. The authors have also carburised and case-hardened samples of iron of low and high oxygen contents, and have found that this can be done without difficulty. They conclude that the oxide particles appear to be practically unaffected by the process. This is certainly a matter of some importance.

Part III. of the research is contributed by Mr. Rooney, and deals with the estimation of oxygen in "pure iron." He has found that the best temperature for complete reduction of the oxide by hydrogen is between 1150° and 1200° C., and suggests that the problem of reducing it depends not so much on the facility with which the hydrogen can penetrate into the metal as on the ease with which the water-vapour formed can escape. Another method used is that described by Oberhoffer and Keil, which consists in heating millings with a proportion of an alloy of antimony (40 per cent.) and tin (60 per cent.), and collecting and weighing the water-vapour produced in the ordinary way. These two methods gave substantially identical results. H. C. H. C.

Seasonal Changes in Shell-fish.

MR. H. MUNRO FOX, in a paper published in the Proceedings of the Royal Society (B, 671) in January last, entitled "Lunar Periodicity reproduction," refers to vol. ii. of the Philosophical nsactions, published March 1667, by Henry Olden- g, Sec.R.S., wherein, at p. 419, may be found the owing question, forming one of a series comprised er the heading, "Inquiries for Suratte, and other cts of the East-Indies"—"Whether those shell- ses, that are in these parts plump and in season the Full Moon, and lean and out of season at the v, are found to have contrary Constitutions in East-Indies."

Modern zoology, through Mr. Fox, has answered s old-time question in detail; but there are e considerations that may be suitably advanced. is well known, in the earliest years of the Royal ciety, the promotion of knowledge by means of correspondency" with diligent persons in various rts of the world was encouraged in every possible y. Lists of inquiries were drawn up by fellows the Society, who were severally charged with the k of reporting such information as could be ured, or see that it was communicated to Olden- g. That zealous officer, with the prevision for ich he was famous, took care that such inquiries uld be placed on record in the Transactions, spective of replies. He desired to have "con- nations of the truth of these things from several nds before they be relyed on."

As regards the particular question which engaged . Fox's attention, it would appear that it was swered—though in the briefest fashion—by the rson to whom the whole body of inquiries was dressed, none other than Sir Philiberto Vernatti, en resident in Batavia. Sprat's "History of the oyal Society" was published in 1667, and in this prints the "inquiries" for the East Indies, but es further than Oldenburg, inasmuch as he supplies e original answers. It is matter for conjecture w it came about that Oldenburg only furnished e questions, whilst Sprat gave these, supplemented by the replies. The reply respecting shell-fishes was, "I find it soe here by Experience at Batavia, in oysters and crabs."

It is interesting to record the origin of the East India inquiries. So early as 1664, Vernatti had sent over a wooden case containing an "East-India present." The case was opened at a meeting of the Society, and at the same time the answers returned by Vernatti to inquiries which he had previously received (recommended to him by Sir Robert Moray), were read and ordered to be registered. Further, Moray was desired to write a letter of thanks for the double gift, and to take care that an order be drawn up for moving the East India Company by favour of the Lord Berkeley, that they would please to recommend such kind of inquiries to their correspondents in the East Indies, and take care of the conveyance of what should be committed to them for the Society.

Afterwards, Dr. Wilkins was desired to speak to his lordship, that he would, in the name of the Royal Society, move the committee of the Company to give their interest. Wilkins reported later that the Lord Berkeley had spoken with several of the Company and certain "very inquisitive men, now in town," who were thought able to answer queries. If unable, these queries would be put before their resident factors. Whereupon, Dr. Wilkins, Dr. Croune, and Mr. Colwall were charged with the prosecution of the matter. As an issue, towards the end of the year Dr. Wilkins acquainted the Society that some of the East India Company were ready to attend them, and it was ordered that the president (Viscount Brouncker), and as many of the committee for correspondence as conveniently could, should give them a meeting forthwith at some place to be agreed upon. Following these engagements, we hear no more of the undertakings until the year 1667.

In general connexion with the foregoing, it may be mentioned that in the Philosophical Transactions for 1669 a paper is printed entitled "On the odd turn of certain snails contrary to the solar turn."

Tests for Scholarships and Promotion.

IN the United States there are no scholarships offered to children passing from the primary to the secondary schools, and, except perhaps in New York, only a comparatively small number of scholarships are awarded for entrance into the universities. Moreover, the bases on which they are awarded are extremely numerous. These facts had to be borne in mind at the joint discussion of the Sections of Education and Psychology of the British Association at Toronto, in which eminent American men of science participated.

In Great Britain, on the other hand, scholarships are awarded on the results of tests, and it is therefore essential to investigate how well these tests—whatever their nature—are performing their function. At present, the most critical age is about eleven, when the child sits for the secondary school scholarship, but, as pointed out by Dr. Cyril Burt, the age of seven or eight, when children are promoted from the Infants Department to the Senior Department, is a neglected but crucial stage in the child's life, as his subsequent success in the scholarship examination may depend upon it. In fact, tests for scholarships to secondary schools are merely a particular case of tests for promotion. Thus, there may be tests for departmental promotion, for class promotion, for scholarships to secondary schools, trade schools, or even to the universities. Both in Germany and in the U.S.A. classes for gifted children have been formed, and it is argued that if psychological clinics are needed for selecting dull and stupid children, *a fortiori*, they are an essential prerequisite in selecting gifted children.

Prof. Whipple (U.S.A.) brought forward evidence to show that the selection of a class of bright children merely from those recommended by the teachers would have resulted in ignoring half of the brightest boys and girls; further, that pupils properly selected can accomplish two years' work in one, even under a mediocre teacher. Teachers are also likely to select for such work a number of pupils that ought not to be selected and that are certain to fail in the attempt to double their pace. It may be observed, in passing, that this question of determining what should be the acceleration of each pupil requires some caution, but, at present, it is rather beyond the province of this résumé.

Prof. Buckingham (U.S.A.) also showed that mental tests will prophesy with respect to the most capable children a rather high minimum of scholastic success, and will do this with high trustworthiness. This result was also shown to hold for university studer and it may be remarked that intelligence testing university students has become fairly general in t United States. Reference was made to investigatio carried out at Syracuse University, where a gr correlation of plus 0·60 between academic success a intelligence was obtained. It was found, howev that the relationship is closer among the more capal students and not so close among the less capable, that, for the purpose of selecting successful studen the intelligence test is more trustworthy than t correlation coefficient, depressed as it is by the presen of the duller students, would lead us to expect.

There is now a mass of evidence obtained by i dependent investigators in different countries whi enables an unprejudiced observer to draw certa broad conclusions, namely: (1) There exist at prese certain mental scales of proved use in assessing t innate mental ability of pupils. (2) Even the jud ments of capable teachers, when made independently such tests, are often untrustworthy and unjust. Wh these two conclusions are generally accepted, it seer difficult to avoid the further conclusion either th teachers should be trained in the use of such tests, else that all cases involving the assessment of t mental ability of an individual should be decided l qualified testers. Further, there is considerab evidence that children of high intelligence are al quite preponderantly children of good growth rat sound health, good social spirit, industrious, ar bitious, eager, and possessed of initiative and resourc fulness, who would unquestionably profit by reasonab educational acceleration and enrichment.

It is well worth while, however, to investigate wh should be the *reasonable* educational acceleration each pupil. It is often said that it takes all sorts make a world, and objection may be made to t draining of the brightest children from a class; ar further, that if the pupils in a class were as alike peas in a bag, that class would be dull indeed. B let it not be forgotten that the advocate of such procedure would be as rare and impractical as h antithesis who would abolish examinations altogethe even assuming that a psychologist could somewhe be found able to select such a class. The commo sense point of view would seem to be that of mo teachers, namely, that reasonable acceleration desirable, which means that more suitable treatme should be given to the brightest as well as to t dullest pupils for their own sakes, for the sake of t teachers, and for the sake of the community.

Vegetative Propagation in the Tropics.

PROBABLY no scientific problem more urgently needs attention in tropical agriculture than the establishment of standard yielding plantations from selected plants by methods of vegetative propagation. The commercial demand in the centres of distribution is always for a regular supply of produce of standard quality, and so long as the grower collects his crop from a plantation of chance selected seedlings of almost infinite variety, this commercial requirement cannot be met. With increasing competition, as supplies of tropical products arrive from new centres, as the development of tropical areas proceeds apace, it was certain that this point would gradually be grasped, and that, if cultural conditions permitted, the produce from vegetative propagation of standard varieties would oust the original variable supply from seedling stock, just as in Europe, and now in the United State vegetative propagation is the rule over all the va acreage supplying the world's needs in table fruit.

It is very instructive, for example, to read in Pro Hendrick's book, "The Peaches of New York," tha isolated experiments upon grafting peaches were mad in the United States from 1770 onwards, largely upo the repeated insistence of English colleagues on th value of the method; but in the period between 182 and 1860 the value of the uniform product thus avai able was realised, nurseries seemed to spring from th ground by magic, and whilst before that there wer millions of peach trees grown and few varieti recognised, in that period some 400 varieties wer carefully propagated and described, a number that b 1900 had reached a thousand.

ritish tropical possessions are as yet ill provided
the large and well-staffed experimental plantaics, on which alone the experimental work can be
ied out that is necessary before vegetative proaation can be resorted to upon a large scale with
taple crop. Unless provision is made for the
xerimental work and for the demonstration of the
e methods to the staffs of the commercial plantaics, a few decades may see British tropical prots ousted from the markets by the more trustthy produce from tropical areas developed by
er nationalities upon more scientific lines. In this
onexion the Ceylon journal, *The Tropical Agriurist* (vol. 72, No. 2), undoubtedly does good service
oBritish tropical agriculture by republishing the
ers by A. A. M. N. Keuchenius upon the vegetative
rpagation of tea and by Dr. P. J. S. Cramer upon
rafting in coffee culture, the latter being translated
rn the Dutch by H. L. Ludowyk, librarian to the
eylon Department of Agriculture. Thus is made
ailable to English readers the valuable scientific
rk carried out under Government auspices in the
Dtch East Indies.

The Java experiments upon vegetative propagation
the tea-plant were the natural corollary of the
section experiments carried out upon this plant at
d Government's Cinchona Plantations. Keuchenius
scribes no less than thirteen different methods
vegetative propagation which were tried, but
wilst only 2 per cent. of cuttings were successfully
opagated by placing branches, stripped of leaves,
moist sand, with crown-grafting an average of 74
cent. of successes was obtained, with rectangular
ch-budding about 87 per cent., and by upright stem
aering, in which roots were encouraged to arise above
ng in the bark by enclosing this region of the stem
soil held in a split bamboo, more than 50 per cent.
re successful.

Dr. Cramer's paper will well repay perusal because
its very general survey of vegetative propagation
the tropics, reference being made to the work at
e experiment stations at Lampongs and at Bangelan,
wich has been directed to exploit the possibilities
vegetative propagation of all the principal industrial
nts. He points out that the first experiments
on grafting coffee were initiated in order to protect
e highly valued Arabian coffee from eelworm
acks by placing them upon a resistant root
stem. He describes also the Klein Getas graft
it was known in Central Java, a valuable hybrid
nt which its owner, Dessauvagie, of course,
iled to reproduce from seed; it was perpetuated
the success of the owner of the Klein Getas estate
propagating it by grafting from, in the first place,
o branches which he succeeded in obtaining from
e original tree. It is unfortunate that in the transked account the word graft-hybrid, which has quite
adifferent connotation in recent literature, is frequently used for this propagation of a valuable hybrid,
otained by ordinary pollination means, by the
olinary method of grafting.

Dr. Cramer has been advocating grafting in the
se of coffee since 1907 in order to arrest the deteriorain that was manifest in Liberian coffee; he has had
a uphill task, but since 1914, when he took charge of
te Coffee Experiment Station at Bangelan, he has
en able to carry out his experimental plans upon
a extensive scale. He has now no less than 250
mall plots, grafted from separate selected parent
ees, 139 larger plots in which selected grafted forms
re being developed to provide scion shoots for larger
ectare plots; 30 hectare plots with 1100-1600 plants
each plot were planted at the end of 1918–19.
Records of the plots are being kept, the grafted plants
elding a regular harvest since the trees came into bearing. On a number of old plantations, trees have been cut back and grafted, the plantations thus being rendered a good deal more productive and the yield, of course, more uniform. This work has shown that the process of transformation to a grafted plantation can be carried out gradually, and the loss resulting from the crop one has to forgo is thus minimised.

University and Educational Intelligence.

ABERDEEN.—The following appointments to assistantships have been made: F. W. F. Hendry (agricultural chemistry); R. G. J. Fraser (natural philosophy); W. Niven (pathology); W. J. Ironside (veterinary hygiene).

CAMBRIDGE.—Prof. A. C. Seward, Master of Downing College, has entered into office as Vice-Chancellor of the University for the Academic Year 1924-5.

DURHAM.—Sir William Bragg, Fullerian professor of chemistry in the Royal Institution, opened the new College of Pure Science in October 1. After the ceremony, Sir William Bragg was given the honorary degree of D.C.L.

Applications are invited by Armstrong College for an adviser in agricultural mycology and an advisory agricultural economist. A British University degree is necessary; also some agricultural experience. Applications (10 in number) should be sent not later than October 20 to the Registrar, Armstrong College, Newcastle-upon-Tyne.

GLASGOW.—The King, on the recommendation of the Secretary for Scotland, has approved the appointment of Dr. H. H. Dixon, professor of botany in the University of Dublin, to be Regius professor of botany in the University in succession to Prof. F. O. Bower.

LONDON.—The following four candidates have been nominated for the by-election for the parliamentary representative of the University of London, in succession to the late Sir Sydney Russell-Wells: Sir John Rose Bradford (Conservative); Dr. F. G. Bushnell (Labour); Dr. E. G. Graham Little (Independent); Prof. A. F. Pollard (Liberal). The first three are medical men, while Prof. Pollard is professor of English history at University College. Polling, which will be by voting paper only, will take place on October 13-17, closing at 5 P.M. on the latter date. The results will probably be announced at 11 A.M. on October 18.

The vacancy in the Senate of the University caused by the death of Sir Sydney Russell Wells will be filled at the meeting of Convocation to be held on Tuesday next, October 14. There are three candidates, namely, Prof. Dame Helen Gwynne-Vaughan; Sir Josiah Stamp, the distinguished economist and statistician; and Dr. J. S. Bridges. Dame Helen Gwynne-Vaughan is professor of botany at Birkbeck College, and has for many years taken an active part in the work of the University. The XXth Century Society of London Graduates is strongly supporting her candidature, and has issued a circular, a copy of which has reached us, describing her many public services, and referring to her important contributions to botanical science. In her election address, Dame Helen remarks, in stating the main principles for which she stands:—" Situated at the heart of the Empire and in touch with unrivalled materials for research, the University has imperial responsibilities which can only be met by greatly increased provision for postgraduate study; places should be available not only for our own graduates

but for students from all parts of the Empire and beyond. This is especially the case in the Faculty of Science. The part which scientific workers can play in the life and government of the nation, and the value of their services are as yet insufficiently recognised. It should be the function of the University to educate the public in an appreciation of scientific discovery and to extend our knowledge by facilitating research."

A course of three free public lectures on "La Douleur, au point de vue des fonctions affectives et perceptives" will be delivered, in French, by Prof. H. Piéron, of the Sorbonne, at Bedford College for Women, on October 21, 22, and 24 at 5.15. No tickets will be necessary.

MANCHESTER.—An assistant lecturer in electrical engineering is required at the Municipal College of Technology. Forms of application may be had from the Registrar. They should be returned by, at latest, October 22.

APPLICATIONS are invited for two lectureships in pure mathematics, one senior and another, in the University of Cape Town. Ability to teach actuarial mathematics and statistics is desirable. Applications, in duplicate, must be sent (upon a special form) to reach the Secretary, office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2, by, at latest, October 28.

THE eleventh centenary of the University of Pavia is to be celebrated in May next, for it was in A.D. 825 that the University was made the centre for higher education in Lombardy. Part of the celebration will be the raising of a monument to Lanfranc, a member of the University, who afterwards became Primate of England; scientific workers will, however, more readily associate with the University the name of Volta, the distinguished professor of natural philosophy.

DR. M. C. RAYNER, joint author with her husband, Prof. W. Neilson-Jones, of "A Text-book of Plant Biology," and also author of a number of botanical papers, has been awarded a Theresa Seessel research fellowship for the year 1924–25 in the Graduate School of Yale University, for work in botany. The fellowship, which is of the value of 1500 dollars, was founded "to promote original research in biological studies," and involves residence in New Haven during the college year, October-June.

THE University of Bombay has received a gift of Government paper worth nearly 50,000*l.* for the endowment of university scholarships for Mohammedan students going to foreign countries for higher studies in medicine, philology, ancient history, Arabic, architecture, town-planning, and technological and industrial subjects, and in preparation for Government service. An interesting feature of the scheme is that the scholarships are to be considered as advances repayable with interest when the scholar obtains regular remunerative employment. The donors are the trustees of the educational trusts founded by Sir Currimbhoy Ebrahim and his daughter. We regret to record that Sir Currimbhoy, who has for many years been associated as a generous patron with numerous educational enterprises, especially Moslem schools, colleges, and orphanages, and the Institute of Science of Bombay, died on September 26 at the age of eighty-five, shortly after the announcement of this munificent gift.

Early Science at the Royal Society.

October 12, 1663. This meeting being appointed for the farther consideration of experiments fit to entertain his majesty with, several of the members present were charged to be curators of the following experiments—Mr. Boyle, To try the magnetical experiment of altering the polarity by repercussing the extremes of an iron rod, made red-hot and refrigerated; and also of destroying all the magnetism by striking it in the middle. To destroy the attractive virtue in a load-stone by heating it red-hot, whilst it keeps the directive virtue.—Dr. Ent, To bring in the anatomy of a lobster and an oister.—Mr. Hooke [among other experiments], To make an artificial eye; to try the casting of a picture on a wall in a light room; to make a hygroscope with the beard of a wild oat.

1664. It was mentioned that there was an instrument made for measuring the swiftness of the wind; and that Sir William Petty had observed that a wind-mill with an ordinary blast of wind turned so often, as to go after the rate of about sixty miles in an hour. He was desired to take care of these experiments, and to observe particularly the difference of the velocity of forced and of free wind; and to bring in an account of all.

October 14, 1663. Mr. Clayton related, that a lady having lost one of her teeth, a porter was hired, one of whose teeth was drawn by La Roche, and put into her mouth where it grew firm. This was confirmed by Dr. Whistler, who related that the same La Roche hit on this art accidentally, having once drawn out the wrong tooth of a countryman; for which mistake La Roche finding him extremely enraged, he told him that if he would have a little patience, he would put the tooth in, and make it grow again as firm as before; which he accordingly did, setting in the good tooth and putting the gums carefully about it.

October 15, 1662. Sir Robert Moray gave an account of his majesty's favour to the society, in declaring his pleasure, that no patent should pass for any philosophical or mechanical invention, but what was first put to the examination of the society.—He mentioned likewise a proposal likely to be speedily referred to them, of making iron with sea-coal.

October 16, 1661. Six balls of a like size were produced, one of lignum vitæ, one of stone, two of tin, and two of lead; to try their different velocity of sinking in water, or falling down in the air.—Dr. Pope made his experiment of breaking pebbles with his hand; which succeeded very well.—Mr. Greatoricks tried what he could do in the compression of water; but being not then prepared, he did not succeed.—Sir Robert Moray acquainted the society that he and Sir Paul Neile had kissed the king's hand, in the society's name; and he was desired by them to return their most humble thanks to his majesty for the reference, which he was pleased to grant of their petition; and for the favour and honour done them of offering himself to be entered one of their society.

October 17, 1666. Mr. Povey mentioned, that there was a certain moving sand in Suffolk, that was driven from one part of the county to the other, and had laid waste great parcels of land, and dam'd up a river; a full description of which he promised to procure with the first convenience.

1667. The experiment appointed for the next meeting, upon the suggestion of Mr. Hooke, was that of making the blood of an animal pass from one side to the other out of the vena arteriosa into the aorta, without passing through the lungs. Dr. Lower and Mr. Hooke were desired to take care of this.

Societies and Academies.

PARIS.

Academy of Sciences, September 8.—M. Emile Roux in the chair.—René **Maire**: The alpine vegetation of the Morocco Grand Atlas. Hooker and Ball, in 1871, made a rapid survey, expressed the view that there was no true alpine flora in the Great Atlas. The author's explorations in 1921, 1922 and 1923, in collaboration with MM. R. de Litardière and Humbert, show that there is a clearly characterised alpine flora, commencing on the north side at 3000 to 3150 metres, a short description of which is given.—Constant **Guichuin**: Quetelet's binomial law of probability.—**Wladimir Rylinski**: Michelson's experiment.—A. **Brodsky**: The corresponding temperatures of solid bodies.—**Georges Brus**: The oxidation of nopinene by permanganate. The yield of nopinic acid is increased by vigorous agitation of the non-miscible liquids, and by treatment during the process with a rapid current of carbon dioxide.—J. **Barthoux**: The massifs of Djebilet and of Rehamna (Morocco).—MM. **Rothé, Baroste, Bois,** Mlle. **Dammann** and Mme. **Hée**. Comparison between the explosion of Oppau and that of Nº 23 at Courtine.—E. **Ducloux**: Attenuation of the virulence of *Bacillus anthracis* (spore-bearing form). The immunising power of the attenuated bacillus. The attenuation was produced by a series of cultivations in a broth made from fish liver (*Gadus merlangus*). Experiments on the immunity produced in sheep are described.—G. **Guittonneau**: The production of ammonia from amino nitrogen by the microsiphonideæ of the soil. The results of experiments with glycocoll, alanine, leucine and tyrosine are given. There is generally some conversion into ammonia by the action of organisms, but the amino acids are not attacked with equal facility.—S. **Metalnikov**: The heredity of acquired immunity. Description of experiments on the grubs of *Galleria mellonella*. These were chosen because the eggs develop away from the mother, and into eight generations can be produced in one year. Evidence of the transmission of acquired immunity against the cholera organism M was obtained.

ROME.

Royal Academy of the Lincei, May 30.—V. Volterra in the chair.—F. **Severi**: Reduction of the principles of relativity to their logical and psychological elements.—A. **Piutti** and E. **Boggio-Lera**: Rare gases from volcanic exhalations.—L. **Sabbatani**: New pharmacological observations with sulphur. By simultaneous injection of sulphur and a reagent such as lead phosphate or silver iodide into the animal organism, it is shown that hydrogen sulphide is liberated immediately the sulphur comes into contact with the tissues.—Mario **Ferrari**: Datolite from Monte Cenpotréra (Reggio Emilia).—Teresa **Nocca**: Datolite from Rigollo (Province of Parma). Chemical and crystallographical data are given for this mineral.—Silvio **Ranzi**: Closure of the otocysts, development of the ductus endolymphaticus (or recessus labyrinthi, or aquæductus vestibuli) and its homology in the series of the vertebrates.—E. **Giglio-Tos**: Curious forecasts verified by experimental embryology.—G. **Fidda** and I. **Sciacchitano**: The polar groove and the fertilisation membrane in the egg of the sea-urchin.

SYDNEY.

Royal Society of New South Wales, August 6.—J. C. Anderson, president, in the chair.—W. R. **Browne**: Notes on the physiography and geology of the Upper Hunter River. The evolution of the valleys of the Upper Hunter and its tributaries is discussed. The main determining factors have been differential hardness of the rocks and submeridional Tertiary faulting, which has brought the soft coal-measure rocks against the harder Carboniferous strata. The upper portion of the Upper Hunter east of the fault-plane is probably a superimposed stream brought into being as a result of very extensive flows of Tertiary basalt, now largely eroded over a surface of Carboniferous rocks. The faulting may be continuous from about Werris Creek as far south as Branxton.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 10, No. 7, July).—J. H. **Breasted**: Historical tradition and oriental research. Archæological discoveries in Egypt and the East generally point to the fact that Greek science and civilisation owe much to the Egyptians. Greek legends have, in many cases, been found to be based on fact. The nucleus of tradition is part of the surviving evidence of man's early history.—G. Y. **Rainich**: Second note: electrodynamics in the general relativity theory.—S. K. **Allison** and William **Duane**: The reflection of characteristic bromine X-radiation by a crystal of potassium bromide. Radiation from a molybdenum target tube operated at 63,000 volts was reflected from the 100 planes of the crystal. Evidence was obtained of the characteristic bromine K-series peaks.—Alfred W. **Simon**: Quantitative theory of the influence electrostatic generator. The treatment is mathematical and, it is claimed, can be applied to any static machine.—P. A. **Ross**: Scattered X-rays. Molybdenum K-lines scattered at various angles from heavy as well as light elements show shifts which are stated to be in accord with Compton's quantum theory of scattering.—George P. **Merrill**: (1) On a stony meteorite from Anthony, Harper County, Kansas, and a recently found meteoric iron from Mejillones, Chile. The former is classified as a grey chrondite much discoloured by secondary oxidation. The latter may be the original Mejillones mass which fell in 1874. (2) A meteoric iron from Four Corners, San Juan County, New Mexico. It is a breccia composed of fragments of a fine-grained pyroxenic rock with excess of coarse granular nickel-iron as cementing material.—M. T. **Bogert** and F. H. **Bergeim**: The constitution of Columbia yellow (chloramine yellow).—Cecilia H. **Payne**: A synopsis of the ionisation potentials of the elements.—Clyde E. **Keeler**: The inheritance of a retinal abnormality in white mice. Sections of the eyes of some albino mice showed the absence of visual cells, external nuclear layer and external molecular layers. The defect seems to be inherited as a Mendelian recessive.—W. R. **Miles**: Action of dilute alcohol on human subjects. Ethyl alcohol in dilute solution, broadly speaking, increases pulse-rate, metabolism and skin temperature, and decreases reflex irritability and efficiency generally. Accuracy is more affected than speed. The effect of alcohol appears to be related directly to the average concentration of alcohol found in the urine (samples taken at 30 min. intervals).

Official Publications Received.

Reprint and Circular Series of the National Research Council. No. 55: Science and Business. By John J. Carty. Pp. 8. (Washington, D.C.: National Academy of Sciences.) 20 cents.

Bulletin of the American Museum of Natural History. Vol. 51, Arts. 2 and 3: Further Evidence on the Structure of the Eosuchia; On the Classification of the Reptiles. By R. Broom. Pp. 39-76. Vol. 51, Art. 4: The Position of the "Sparassodonts"; with Notes on the Relationships and History of the Marsupialia. By Horace Elmer Wood. Pp. 77-101. (New York.)

Straits Settlements. Annual Report on the Raffles Museum and Library for the Year 1923. By C. Boden Kloss. Pp. 18. (Singapore.)

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 13, No. 1: Studies in Indian Tobaccos. No. 4: Parthenocarpy and Parthenogenesis in two Varieties of *Nicotiana Tatacum* L., var. *Cuba* and var. *Mirodato*, by Gabrielle L. C. Howard and Kashi Ram; No. 5: The Inheritance of Characters in *Nicotiana rustica* L., by Gabrielle L. C. Howard. Pp. 37+15 plates. Botanical Series, Vol. 13, No. 3: Studies in Indian Fibre Plants. No. 3: On the Inheritance of Characters in *Hibiscus Sabdariffa* L. By Albert Howard and Gabrielle L. C. Howard. Pp. 47-85+6 plates. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 2 rupees; 3s., each.

Memoirs of the Indian Meteorological Department. Vol. 23, Part 8: Frequency of heavy Rain in India. By Sir Gilbert T. Walker. Pp. 413-524. (Calcutta: Government Printing Office.) 3.14 rupees; 5s. 10d.

Conseil Permanent International pour l'Exploration de la Mer. Publications de Circonstance, No. 83: On *Chiridothea Entomon* (L.) in the Southern and Western Baltic. By Anton Fr. Bruun. Pp. 12. Publications de Circonstance, No. 84: Standard Net for Plankton Collections. By C. H. Ostenfeld and P. Jespersen. Pp. 16. Rapports et Procès-Verbaux, Vol. 33: Times of Entering of the Atlantic Salmon (*Salmo salar* L.) in the Rivers. By Osc. Nordquist. Pp. 58+2 plates. Bulletin Hydrographique pour les années 1920, 1921, 1922, 1923. Publié par le Bureau du Conseil, avec l'assistance de Martin Knudsen. Pp. 103. (Copenhague: A. F. Høst et fils.)

Proceedings of the South London Entomological and Natural History Society, 1923–24. Pp. xix+153. (London: Hibernia Chambers, London Bridge.) 10s.

University of Iowa Studies in Child Welfare. Vol. 3, No. 1: A Study of Hereditary and Environmental Factors determining a variable Character; Defective and Freak Venation in the Parasitic Wasp *Habrobracon juglandis* (Ashm.). By Dr. P. W. Whiting. Pp. 80. (Iowa City.) 1.25 dollars.

The Kent Incorporated Society for Promoting Experiments in Horticulture. Annual Report, East Malling Research Station, 1st January 1923 to 31st December 1923. Pp. 138+10 plates. (East Malling, Kent.) 3s.

Birkbeck College (University of London). The Calendar for the Year 1924–25. Pp. 193. (London: Bream's Buildings.)

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1923–24. (Cmd. 2223.) Pp. iv+139. (London: H.M. Stationery Office.) 3s. net.

Bulletin of the Imperial Agricultural Experiment Station in Japan. Vol. 3, No. 1: Über die Verdaulichkeit der Futtermittel bei Hühnern. Von T. Katayama. Pp. 78+2 Tafeln. (Nishigahara, Tokio.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Antigua, 1922–23. Pp. iv+22. Report on the Agricultural Department, St. Kitts-Nevis, 1922–23. Pp. iv+49. (Barbados.) 6d. each.

National Union of Scientific Workers. On the Encouragement of Fundamental Research: Report of the Research Committee presented to the Council of the National Union of Scientific Workers on 26th January 1924, and adopted. Pp. 23. (London: 25 Victoria Street.) 6d.

The University of Colorado Studies. Vol. 13, No. 2: Mollusca of Colorado, Utah, Montana, Idaho and Wyoming. By Prof. Junius Henderson. Pp. 65-223. (Boulder, Colo.) 1 dollar.

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New Zealand: Dominion Museum. Bulletin No. 10: Maori Religion and Mythology, being an Account of the Cosmogony, Anthropogeny, Religious Beliefs and Rites, Magic and Folk Lore of the Maori Folk of New Zealand. By Elsdon Best. Section 1. Pp. iii+264+6 plates. (Wellington, N.Z.: W. A. G. Skinner.)

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Department of the Interior: Bureau of Education. Bulletin, 1923, No. 60: Statistics of Private High Schools and Academies, 1921–22. Prepared under the Direction of Frank M. Phillips. Pp. 53. (Washington: Government Printing Office.) 10 cents.

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the Year 1923. Pp. ii+14. (Livingstonia.)

Department of Public Instruction: Technical Education Branch, New South Wales. Technological Museum: Annual Report for Year ended 31st December 1923. Pp. 4. (Sydney: Alfred J. Kent.)

Government of Madras: Law (Education) Department. Administration Report of the Madras Government Museum and the Connemara Public Library for 1923–24. Pp. 6. (Madras.)

Proceedings of the Royal Society of Victoria. Vol. 36 (New Series), Part 2, 14th August. Pp. 83-264+plates 7-18. (Melbourne.)

Fourteenth Report on the Sarawak Museum, 1915–1923. By Dr. E. Mjoberg. Pp. ii+102. (Sarawak: Government Printing Office.)

Ministry of Agriculture and Fisheries. Report of Proceedings under the Salmon and Freshwater Fisheries Acts, etc., etc., for the Years 1922 and 1923. Pp. 54. (London: H.M. Stationery Office.) 3s. net.

Diary of Societies.

SATURDAY, OCTOBER 11.

BRITISH PSYCHOLOGICAL SOCIETY (at University College), at 3.—Prof. C. Spearman: The New Psychology of "Shape" (Gestalt).—S. A. Hamid: Some Factors of Effectiveness in Mental ("Intelligence") Tests.

MONDAY, OCTOBER 13.

MEDICAL SOCIETY OF LONDON (Annual General Meeting), at 8.—Dr. E. M. Callender: Medical Memories.

TUESDAY, OCTOBER 14.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—Indicator Diagram Lessons therefrom.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Caxton at 7.—H. A. Stirzaker: Safety Valves.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—M. O. The Pyrenees.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Major R. B. S. Sewell: Work of R.I.M.S. *Investigator* and Problems of Tropical O graphy.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Automobile at 8.—Dr. W. R. Ormandy: Research (Presidential Address).

WEDNESDAY, OCTOBER 15.

ROYAL METEOROLOGICAL SOCIETY, at 5.—L. F. Richardson: (*a*) The Corona and the Diameters of Particles; (*b*) Photometric Obse on Clouds and Clear Skies.—L. J. Sutton: Notes on "Haboobs."

BRITISH SOCIETY OF MASTER GLASS-PAINTERS (at 6 Queen Square, at 6.30.—Sir Charles Nicholson: Architecture and Stained Glas

ROYAL MICROSCOPICAL SOCIETY, at 8.—J. E. Barnard and J. Smi Comparison Ultra-Microscope.—Dr. R. S. Clay and T. H. Court: Developments of the Hooke Microscope.—Prof. A. G. Horn Mounting with Venetian Turpentine.—J. Smiles and J. E. Par The Correction of High Aperture Dark-Ground Illuminators.

INSTITUTE OF CHEMISTRY (London Section), at 8.—The Positi Chemistry (Various Papers).

THURSDAY, OCTOBER 16.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30. Rohrbach: Large All-metal Seaplanes.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at —J. S. Jones: Hygrometry for Deep Mines.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Prof. Nunn: The Educational Philosophy of Gentile.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Pictorial Meeting.

CHEMICAL SOCIETY, at 8.—R. Lessing and A. L. Banks: The Infl of Catalysts on Carbonisation.—R. G. W. Norrish and Dr. E Rideal: The Photosensitive Formation of Water from its Elemen the Presence of Chlorine.—J. Kenyon, H. Phillips, and H. G. Tu Investigations on the Dependence of Rotatory Power on Chem Constitution. Part XXIV. Further Experiments on the W Inversion.—Dr. F. L. Pyman and E. Stanley: The Directive Infl of Substituents in the Glyoxaline Nucleus on substitution in Benzene Nucleus of Phenylglyoxalines—the Nitration of 2-ph glyoxaline and its Carboxylic Acids.

ROYAL SOCIETY OF MEDICINE, at 9.30.—Dr. W. T. Grenfell: Medicine Corner of the Empire.

FRIDAY, OCTOBER 17.

SOCIETY OF MEDICAL OFFICERS OF HEALTH (Annual General Mee (at 1 Upper Montague Street, W.C.), at 4.30.—Dr. R. A. Ly Idealism in Public Health.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur K Anatomy and Malformations of the Heart—(1) Specimens illustr the Evolution of the Human Heart.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—T. Th Baker: The Telegraphy of Photographs by Wire and Wireless.

JUNIOR INSTITUTION OF ENGINEERS (at Royal Society of Arts), at —R. P. Howgrave-Graham: High Voltage Electric Oscillations.

ROYAL GEOGRAPHICAL SOCIETY (AND ALPINE CLUB) (at Albert Hall 8.30.—Gen. Bruce, Col. Norton, Capt. G. Bruce, and Mr. Odell: Mount Everest Expedition.

SATURDAY, OCTOBER 18.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 4.—Sir Archibald Garrod: Harveian Oration.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital).

BIOCHEMICAL SOCIETY (at Cambridge).

PUBLIC LECTURES.

SATURDAY, OCTOBER 11.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—R. P. G. Denman: Development of Modern Radio Communication.

MONDAY, OCTOBER 13.

UNIVERSITY COLLEGE, at 5.30.—Prof. E. W. Scripture: Researches Speech and Song.

WEDNESDAY, OCTOBER 15.

UNIVERSITY COLLEGE, at 5.30.—Dr. E. A. Baker: The Use of Librari

THURSDAY, OCTOBER 16.

KING'S COLLEGE, at 5.30.—Prof. H. Wieland: Organic Radicals English).

FRIDAY, OCTOBER 17.

KING'S COLLEGE, at 5.30.—Prof. H. Wieland: Theory of Oxida Processes (in English).

SATURDAY, OCTOBER 18.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Dewey: Cornish Sce and its Causes.

NATURE

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number : GERRARD 8830.
Telegraphic Address : PHUSIS, WESTRAND, LONDON.

NO. 2868, VOL. 114]

Living Religions.

FOR nearly two weeks—from September 22 to October 3—a Conference has sat in London to listen to the tenets of some of the principal living religions of the world as expounded by distinguished adherents. It was held on the initiative of the School of Oriental Studies and the Sociological Society. The Conference, it is believed, was the first of its kind and was intended primarily to be educative It aimed both at disseminating accurate information relating to the religions represented and at removing certain popular misunderstandings. Mohammedanism, Hinduism, Buddhism, Taoism, the religion of Sikhs, Jains and Parsis, and primitive religions were represented, for the most part by members of the British Empire. It thus affords some indication, imperfect perhaps, of the great variety of religious belief to be found within this one political organisation.

An exposition of religious dogma at a conference carries with it something of an academic atmosphere, and, however much it may bring out the contrasts of different systems of religious philosophy, it fails to give full emphasis to their moulding force in determining the practical attitude of those who profess them towards their fellow-men and towards life as a whole. The influence of religion may appear imponderable except in times of conflict and stress. Life in a modern community does, no doubt, obscure it, may even weaken it ; but for the majority of the inhabitants of the world, it is still all-pervasive and fundamental. This is more especially evident in the case of primitive peoples. It is on this account that study of primitive belief and ritual is an essential precedent condition of success in the administration of backward races.

It is not without significance that the religions of India should have taken a prominent place in the proceedings of the Conference. They rest upon a highly developed theological and philosophical basis ; they present marked contrasts ; and perhaps nowhere else is it possible to see more clearly the force of religious belief in determining the form and character of social organisation. In Hinduism the system of caste, with its rigid determination of social grades, the doctrine of asceticism, and the emphasis laid upon meditation as a form of religious practice, permeate every phase of Hindu society. The caste divisions, with the doctrine of untouchables and the specialisation of occupation, have proved, and are likely to continue to prove, an insurmountable obstacle to any lasting social and political unity. They have given a static character to social organisation which stands in the way of development.

The effect of religious belief, however, in the daily life of the people is even more clearly to be discerned when attention is directed to primitive conceptions, not

merely as they appear enshrined as survivals in the highly developed philosophical thought of official Hinduism, but in the popular religion, the traditional animistic beliefs, and the regard for the village deities of the mass of the population which were overwhelmed with the Aryan invasion but are still the predominant element in the popular religion. The significance of the survival of these primitive forms of belief lies in the fact that they still tend to keep alive the village community as the effective social unit. It is noteworthy that the modernist movements in India, which aim at a larger unity, seek to break down what, from the social if not from the philosophical point of view, have been the most persistent features in Hinduism. The reform movements in Hinduism, therefore, both Brahmo-Samaj, with its tendency toward universalism in its later developments, and Arya Samaj, with its militant nationalism, aim at ignoring differences of race and caste and seek to mould India into one people. In the same way the differences in doctrine of other forms of religion, whether Mohammedan, Parsi, Sikh, or Jain, are reflected in their social organisation. Yet if they neither observe caste nor practise asceticism in the strict sense of the term, they do not any the less hold themselves strictly apart. How deep is the line of cleavage can be seen in the bitterness of the conflict between Hindu and Moslem, which is repeatedly manifested upon occasions which might seem trivial to an outside observer. At the present moment the attempt at a reconciliation between the two bodies hangs upon an adjustment of their respective attitudes towards the cow, and whether it may be possible for the Mohammedans to devise a method of slaughter of this sacred animal which will not offend the susceptibilities of the Hindu.

The philosophical character of the sacred books, and the fact that information relating to Indian religion has been too exclusively drawn from literary sources, has tended to obscure the practical effect of religious belief in determining the form of Indian social institutions except in their more obvious aspects. But none the less in India, as in other parts of the world where religious beliefs conform to a primitive type, that attitude towards the hidden powers underlying material things which anthropologists call animism is a dominant factor in the form and content of social life. An instance at once suggests itself. The social organisation of the Todas depends entirely upon the sacred character of the cow; it is arranged to meet the requirements of the ritual of the dairy. An analogous case is to be found in East Africa, where the institution of royalty and the whole of the kingly ceremonial among the Bahima is based upon the sacred nature of the cattle and the dependence of their welfare upon the king. Even the diet of the people and their food taboos, whether temporary or permanent, are related to the sac sanctity of the milk and the care which must be taken protect it from the slightest danger of ritual uncleanne

It would be possible to add almost innumerable stances among primitive peoples in which the form a content of social institutions are directly dependent up the character of their religious beliefs. The widely spre totemic system in its various types, the matriarcha and the prominence given to the mother's brother all matters in which in the patriarchal system t father holds the authority, are instances striking their diversity from our own customs. But, as James Frazer has shown in "Psyche's Task" (Londo Macmillan and Co.), primitive religious ideas und lie some of the most important functions of mode civilised life. Taboos similar to those which are n observed in the islands of the Pacific lie deep root at the base of our ideas of property; the divine rig of kings can trace its ancestry to the sacred ch acter of the chief, whose power may rest either w the fact that he embodies the spirits of his ancesto or that by his power as a magician he can control t hidden forces of the world around. The primiti belief in magic has determined the forms of the la and the invocation of spirits, assisted by the admin tration of poison or other form of test, has grown ir the trial by ordeal out of which our judicial proced has developed, still retaining the administration of t oath, formerly a test and now a guarantee of the hones of a witness.

It may be asked in what sense the term "livi religions" has been applied in selecting the forms religious belief to come before the Conference which h just been held. An attempt to supply an answer the question has been made by Mr. Victor Branford in essay [1] which, although not an official publication, w issued as an interpretative study a few days before t Conference met. Mr. Branford, who is a co-worker wi Prof. Patrick Geddes, would apply the term only those religions which show signs of developing alo the lines of the larger modernism. As an instance his meaning he cites the case of Indore, where t ritual processions have been adapted, at the suggesti of Prof. Geddes, to subserve the needs of the ci in improved sanitation and housing. In the mode State, he beholds a vision of a cult in which the comple unification of the sciences and arts is directed to t cultivation of the highest faculties in man in a civ environment in perfect harmony with that end. The perhaps the matter may be left without too clo an examination of how far the place of religion in actual modern community falls short of this ideal.

[1] "Living Religions: a Plea for the Larger Modernism." By Vic Branford. Pp. xxxvii+290. (London: Leplay House; Williams a Norgate, 1924.) 5s. net.

Primitive Medicine.

Medicine, Magic and Religion: the FitzPatrick Lectures delivered before the Royal College of Physicians of London in 1915 and 1916. By Dr. W. H. R. Rivers. (International Library of Psychology, Philosophy and Scientific Method). Pp. viii + 147. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1924). 10*s.* 6*d.* net.

Had Rivers lived for a few more years, there is little doubt that this book would never have seen the light in its present form. The Fitzpatrick Lectures, which he delivered in 1915 and 1916, are now published practically as they were delivered, but Rivers intended, as Prof. Elliot Smith has pointed out in the preface, to make them the basis of a comprehensive treatise on primitive medicine; and to this end he had already collected an enormous bibliography. The loss to science is therefore incalculable; for Rivers was, just before his death, projecting another advance in knowledge, which only he, of British ethnologists at least, if not in the whole world, was capable of making. Shortly before his death, he said that he was going to make it his business to set out in proper form the doctrine of the biological analogy, which has been so discredited through its misapplication, but, nevertheless, is of the utmost importance to the proper understanding of the social process as a whole. With his incomparable knowledge of medicine, psychology, and of ethnology, he would undoubtedly have produced work that would have added a pinnacle to his fame. But this was not to be, and the world will have to wait until another shall arise capable of the feat.

This book has a twofold interest. In the first place, it is a piece of ethnological research which throws much light on the problem of the relations between medicine, magic, and religion, especially in communities of the lower culture. For this reason it will be valuable to the student, especially as much of the material has been collected by Rivers himself, partly in collaboration with W. A. M. Hocart, in Melanesia. The scene of action is usually placed in Melanesia, but in the latter part of the book a survey of the world is carried out which serves to give a comparative value to the result of his investigations. This line of work is likely to have a considerable influence on ethnological method in the future.

The second feature of interest in the book lies in the fact that Rivers was facing some of the consequences of the change of attitude towards the problem of accounting for the culture which any community possesses. Having broken away from the orthodox school of Great Britain, and taken his stand on the side of diffusion, he was forced to examine every fact that came under his purview from this point of view. The result is illuminating. It is, also, safe to say that had Rivers not adopted, in his "History of Melanesian Culture," the method of culture-mixture, by which he tried to show how various elements of culture might have arisen as the result of the intermixture of two or more cultural streams, it is probable that he would have moved much faster in the direction in which he was travelling than he actually did. Indeed, there is no doubt that it was this preoccupation with the problem of culture-mixture that prevented him for some time from realising the extent of the revolution he had caused. But, at the same time, there is not much doubt that he would have agreed ultimately entirely with the point of view of Elliot Smith. This is shown in his comments on the discoveries in San Cristoval made by Dr. E. C. Fox, whose book is shortly to be published.

The volume under notice consists of five chapters. Each of the four Fitzpatrick Lectures occupies a chapter, and the Rylands Lecture in 1919 on "Mind and Medicine" is published as the fifth chapter. The first chapter is occupied with the discussion of beliefs concerning the causation of disease among various Melanesian peoples. Peoples of low culture usually ascribe disease to the magical actions of some human being, or to some spiritual agency, which either enters the body of the victim, or else abstracts the vital essence and so causes disease. Sometimes minor ailments are ascribed to natural causes. A sorcerer who causes disease can act in one of three ways. He can project some morbific object or influence into the victim's body; he can abstract something from the body; or he can act on some part of the body, or some object which has been in contact with the body. The last case would be termed one of "sympathetic magic" by Sir James Frazer and his school of thought, the idea being that natives imagine that the two disconnected bodies are really in communication by means of "a kind of invisible ether." Rivers believed that this interpretation is mistaken, and that the "contagious magic" of peoples who practise such rites "rests not on any mystical belief in action at a distance, but on the belief that the sorcerer has in his possession part of the soul of another person, part of the vital essence of the person which he wishes to destroy" (p. 27). That is to say, the magical procedure of these peoples rests on a concrete, logical basis.

Then comes an interesting chapter dealing with diagnosis and prognosis, the bases of which are magical and religious. In this chapter Rivers is at pains to show that the religious element is far more important than is usually assumed, that the formulæ which form so constant a part of the magical rites are very often

supplications, appeals to higher powers, and not charms which are supposed to be efficacious in themselves.

As a result of the native theory of the causation of disease there has been produced, in certain places, an immense variety of specialisation. For example, in Eddystone Island of the Solomons, there is a degree of specialisation that puts Harley Street "in the shade." Practitioners are to be found there who deal exclusively with rheumatism, fever, epilepsy, insanity, and so forth; each has his own particular technique and knows nothing of the manner of treatment of other complaints—a "division of labour" *in excelsis*. Rivers lays great stress, also, on the part played in medical practice among peoples of low culture—in contrast, is it possible, with their more civilised brethren?—of suggestion. He suggests that the savage practitioner is less of an impostor than we are apt to believe, and, what is more, he goes so far as to suggest also that the modern quack is not necessarily always a humbug, but that he may have implicit faith in his nostrum.

The second half of the book is concerned with the problem of transmission of culture. Here Rivers discusses from this point of view the medical practice of various parts of the world, as well as different forms of medical treatment. He shows, for example, that two theories as to the causation of disease are widely held. One, which ascribes disease to the abstraction of the vital essence, is held in Indonesia, Papuo-Melanesia, and America. The other view, that disease is the result of possession, is found pre-eminently in India and Africa. Rivers comments: "If the phenomena of disease are much the same all the world over, and if the similarities of belief and action are due to the uniformity of the human mind, how comes it that men should have been led to these very different beliefs and why should these beliefs have different distributions?" Again he brings forward the case of remedies of what he terms the "domestic order"—massage, vapour-baths, venesection, cupping, and similar treatments, and comments thus:

"Highly as we rate our civilisation, it did not enable us to discover for ourselves practices which, according to advocates of independent origin, must have been discovered by the Melanesian and Papuan. We acquired our practices of bleeding and counter-irritation from the Greeks or Arabs, our massage from the French or other continental people, and our vapour-baths from the Turks and Russians. The civilisation of which we are so proud did not of itself suffice to teach us these remedial arts, but we had to acquire them by contact and mixture with other peoples. If we are to accept the teachings of those who believe in the independent origin of such practices in Africa, Asia, Oceania, and America, we shall have to accept the position that the savage or barbarous peoples who inhabit these co[n]ents and islands were somehow able to discover [t]hings which we, who think ourselves so greatly their superi[o]rs, were content to learn from other peoples" (p. 85).

Rivers then proceeds to discuss the mechanism of culture-transmission, and to show what modificati[o]ns may be produced during the process, taking medical practice to illustrate his points. This is one of the most important chapters in the book, revealing as it does, with the utmost clarity, the attitude which Rivers then adopted towards the general problem of the transmission of culture, the problem which is bound, in the next few years, to occupy most of the attention of ethnologists. He studies the factors which determine the survival value of an introduced element of culture, as well as the modifications which it undergoes as the result of introduction into a new environment.

In the course of this discussion, Rivers lays special stress on the factor of degeneration, which he certainly, so far as our knowledge goes, was the first to stress and to study in detail. He says:

"We are only now emerging from a period in the study of human society during which the factor of degeneration has been almost wholly neglected or greatly underrated, even in the case of the ruder phases of human culture"—adding, also, the characteristic caution: "In seeking to show how great a part degeneration has played, and is still playing, in the history of human society, we must be careful not to go to the opposite extreme, and overrate its frequency and importance" (p. 110).

The final chapter, "Mind and Medicine," is already familiar to many of the readers of NATURE. It is the result of the experience gained by Rivers during the War, when he had charge of men suffering from "war strain." Rivers was one of the first medical men in Great Britain to advocate and to clarify the views of Freud and his school concerning psycho-pathology, and in this chapter he adumbrates the application of the results of this work to the study of human society and its disorders, which certainly would have formed the great task to which he would next have turned his attention. His masterly treatment of self-knowledge, self-reliance, and suggestion in their social aspects is bound to have important repercussions in the domain of social psychology.

The reader of this work must certainly come away with the feeling that had Rivers lived for another ten years, so as to have been able to gather together the treasures which he had won in so many departments of knowledge, the science of anthropology would have been incalculably the richer. It is a tragedy that he should have gone just when his powers were coming to the full maturity, when he was at last coming into his own.

W. J. PERRY.

Relativity.

(1) *Théorie quantique des spectres. La Relativité.* Par Norman Robert Campbell. (Supplement à l'ouvrage: La Théorie électrique moderne; théorie électronique.) Traduit de l'anglais par A. Corvisy. Pp. 237. (Paris: J. Hermann, 1924.) 18 francs.

(2) *The Theory of Relativity: Studies and Contributions.* By Archibald Henderson, Allan Wilson Hobbs, and John Wayne Lasley, Jr. Pp. xiii+99. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1924.) 11*s.* 6*d.* net.

(3) *Teoria della relatività: saggio di una esposizione secondo il senso fisico.* Da Prof. Paolo Straneo. Pp. 161. (Roma: Dott. G. Bardi, 1924.) 15 lire.

(4) *Einführung in die Tensorrechnung.* Von Prof. Dr. Hermann Rothe. Pp. iv+179. (Wien: L. W. Seidel und Sohn, 1924.) 5*s.*

THE literature of the theory of relativity and of the subjects allied to it is increasing so fast that it is becoming very difficult for any one to keep pace with it, but several of the books in the collection under review present their subject in so novel and interesting a manner as to be well worthy of the attention of the most seasoned student of relativity. Little need be said of the first book (1), for it consists merely of the French translations of the two chapters on the quantum theory of spectra and the theory of relativity issued as supplements to Dr. N. R. Campbell's well-known book on "Modern Electrical Theory." It will be sufficient to state that the French translation expresses the meaning of the original text clearly and fully. It is well printed and commendably free from misprints—the few that remain are fairly obvious and unlikely to mislead the reader—and will certainly prove helpful to those French students of experimental physics to whom the more mathematical text-books on relativity by Becquerel and Galbrun are a stumbling-block.

(2) The second volume gives a succinct account of Einstein's special and general theories of relativity and of the physical experiments on which they are based and by means of which they can be tested. The first chapter of nine pages, by A. W. Hobbs, treats of some experimental anticipations; it is noteworthy for a very clear account of the theory of the experiment of Michelson and Morley. The second chapter of sixteen pages, by A. Henderson, gives a brief account of the special theory of relativity on conventional lines, whilst the third, by the same author, in forty-six pages deals with the general theory of relativity, including tensor analysis, and its consequences. Both chapters are remarkable for the clear enunciation of the fundamental principles postulated by Einstein and for the unusually complete and up-to-date treatment of the experimental tests of the theory, particularly the deflexion of rays of light and the displacement of spectrum lines. The fourth chapter of twenty-six pages, by J. W. Lasley, Jr., gives a complete, though concise, account of the curvature of manifolds according to the definitions of Gauss, Riemann, and Einstein, as an aid to the understanding of the geometry of the Einstein space. This may perhaps be regarded as the most distinctive feature of the book. Naturally a complete statement of the theory and its consequences cannot be expected in so restricted a space, but the treatment is clear and thorough so far as it goes. The book can be recommended as a brief summary of the theory, although it may, owing to its brevity, very well prove somewhat difficult reading for those who have not already acquired some knowledge of the subject from one or other of the standard treatises.

(3) Prof. Straneo's "Teoria della relatività" is conceived on unusual lines: its purpose is not so much to give a complete account of the theories of relativity, special and general, developed by Einstein and his followers, as to supply physical interpretations of the different stages of their development and of the various results deduced from them. In this respect it invites comparison with Dr. Campbell's supplement, but whilst the latter is written specifically for physics students commencing their study of the theory of relativity, the former appeals to a wider circle of readers, more especially to those who already have a considerable acquaintance with the theory in its mathematical aspects. To these it offers a most interesting and stimulating presentation of an aspect of the theory too often neglected in favour of a more formal treatment, and thus it fills a distinct gap in the literature of relativity. About ten pages are devoted to a sketch of prerelativity physical theories, sixty to the special theory of relativity, ten to the period of transition, and sixty-five to the general theory. In accordance with the plan of the work, mathematical developments, though of course not absolutely ignored, are relegated to the background, whilst particular attention is given to the exhibition of the physical meaning of the various steps in the analytical formulation of the theories and the methodical explanation of the arguments employed in their development.

The general attitude of the author is perhaps best characterised by two theses frequently insisted upon in the book. The first is that the theories of relativity are physical theories and therefore, like other physical theories, must be judged by their capacity for subsuming and explaining the facts of physical experience as a whole, rather than the particular effects so often insisted upon, such as the motion of the perihelion of Mercury, the deflexion of light by the sun and the

displacement of spectrum lines, all of which are on too minute a scale to afford decisive criteria for the acceptance or rejection of theories of so wide a range. The second thesis is that the theories of relativity afford an opportunity for, but do not absolutely compel, a revision of our fundamental ideas of space and time. For though they establish an entirely new relation between them and enable us to use the four-dimensional space-time continuum as a convenient system of reference, yet they leave us with so great a difference in character between the two concepts, that we need not renounce our intuitions of them as essentially different. This truly fascinating monograph offers so much that is new and suggestive within a narrow compass that it can be read by every student of relativity with great profit, be he mathematician, physicist, or philosopher; its translation into English is very much to be desired.

(4) "Tensorrechnung," by H. Rothe, constitutes the first part of a projected treatise on tensor analysis and is an excellent introduction to tensor algebra. It may very well be reviewed with the other books of this collection on account of the close connexion of its subject-matter with the theory of relativity. In about one hundred and eighty pages it deals with its subject exhaustively, but at the same time assumes so little previous knowledge of higher mathematics and is written in such a clear and full manner, that students with even a very slight mathematical equipment can be expected to derive considerable benefit from its study and to find it a great help towards the understanding of standard works on the general theory of relativity. In spite of the fact that complete generality is attained, particularly in the later chapters, the author has contrived, by a judicious and gradually progressive arrangement of his theoretical material and a free use of well-chosen and fully worked examples, to lead the reader onwards from the theory of manifolds of two, three, and n dimensions, by way of the theories of scalars and vectors, to the theories of tensors, linear vector manifolds, and tensor fields of the most general types.

In general, the author has restricted himself to algebraic methods, such as the processes of addition, multiplication, and contraction ("Verjüngung"), and has reserved the study of differential and integral processes for another volume. It is very unfortunate that the completion of the work was cut short by the premature decease of the author; but even in its present incomplete state the book, in so far as it constitutes a complete treatise on tensor algebra, supplies a distinct want and forms one of the best introductions known to the present writer to a difficult and important subject. Like Straneo's work, it is well worthy of translation.

Aeronautical Science.

(1) *Elementary Aeronautical Science.* By Ivor B. H[art] and W. Laidler. Pp. vi+288. (Oxford: Clarend[on] Press; London: Oxford University Press, 192[4]) 7*s.* 6*d.* net.

(2) *Les Hélicoptères: Recherches expérimentales sur [le] fonctionnement le plus général des hélices: Études [de] le mécanique de l'hélicoptère.* Par W. Margou[let]. Pp. xi+90. (Paris: Gauthier-Villars et Cie, 192[4]) 10 francs.

(3) *Étude sur le ballon captif et les aéronefs mari[times].* Par Le Commandant Charles Lafon. Pp. vi+2[00]. (Paris: Gauthier-Villars et Cie, 1922.) 20 francs.

(4) *Sur la théorie des surfaces portantes.* Par Maur[ice] Roy. (Collection "Scientia," No. 39.) Pp. 1[00]. (Paris: Gauthier-Villars et Cie, 1923.) 12 francs.

(1) AN obvious need in aeronautical literature is [a] book giving a reasonably competent accou[nt] of the principles of aviation, and not merely popular [and] spectacular on one hand, but not containing mass [of] of technical detail of an engineering or mathematic[al] character on the other. Messrs. Hart and Laidle[r]'s book is an attempt to provide for this need: it [is] intended primarily for young students among t[he] aircraft apprentices in the Royal Air Force. T[he] mathematical equipment of such readers is necessari[ly] slender, and the authors do not use any more advanc[ed] mathematics than elementary algebra and trigon[o]metry, with a few exceptions where the calcul[us] notation has had to be employed. It may be said [at] once that the book seems at least to be a very goo[d] attempt in a new direction. It is pleasantly writte[n] fairly full but not too big, comparatively cheap an[d] nicely got up, with numerous interesting illustrations.

There are three parts. The first is devoted t[o] historical and mechanical introduction. Part ii. give[s] the elementary principles of flight. Part iii. dea[ls] with the structure of the aeroplane, its parts, the engin[e] instruments, etc.

The historical portion of Part i. is a survey of th[e] development of aviation from the earliest times to th[e] present day. A lot of space is devoted to Leonard[o] da Vinci, while the work of the last twenty years i[s] dealt with very summarily—a rather serious error [in] perspective. The mechanical portion consists of [a] brief survey of the most important facts and formul[æ] of elementary mechanics, a useful reminder of thing[s] that presumably the student knows already: other[-]wise it can be of very limited utility.

In Part ii. the authors, after a brief reference to th[e] ornithopter and helicopter, turn to the main topic of th[e] book, namely, the aeroplane. The aerofoil is introduce[d] and its various characteristics. A really gallant effor[t]

is made to explain stability without the use of mathematical analysis, while control, manœuvres, and stunts complete a particularly successful and brief statement of the aeroplane and its motions in about 90 pages of print. Part iii. discusses the air-screw, graphical statics of aeroplane structures, and all the topics associated with the structure and manœuvring of aeroplanes. An excellent feature of the book is the large number of easy exercises, mostly numerical, to which answers are given. We can have no hesitation in recommending this excellent book to all students who wish to gain an elementary knowledge of the aeroplane. We would suggest, however, that in a later edition some effort should be made to justify the epithet "aeronautical." In its present form the book is really "elementary *aeroplane* science," and not "*aeronautical* science." The student would understand aeroplane flight much better if he had side by side with the theory of the aeroplane a brief and equally competent account of the airship and the balloon: the contrast in sustentation and the analogy in control would be eminently educative.

(2) From time to time we are allowed a peep behind the scenes and told of the progress made in the designing of helicopters in Great Britain and elsewhere. While it may be doubted whether the special encouragement given to this type of aerial locomotion will be justified by events, the attempt to produce efficient and stable machines on the helicopter principle will be not only a practical achievement of great significance, but will also represent a source of useful information that will have its repercussion on other branches of aeronautical study and practice.

M. Margoulis attacks the problem of the helicopter from its fundamental aspects, *i.e.* he bases his book on the study of the air-screw in its most general form. He first takes the case where the plane of rotation of the screw is perpendicular to the direction of motion, paying particular attention to the fixed air-screw. He then uses the results of observations made at St. Cyr, at the National Physical Laboratory, and by Riabouchinsky, to discuss the general case in which the plane of rotation makes any angle with the direction of motion. The results are applied to the helicopter in the form of an aeroplane, with air-screws rotating round vertical axes for purposes of sustentation when the horizontal speed is small or nil. Vertical flight and horizontal flight are discussed separately, and then the case of general flight is considered.

(3) M. Lafon's book has a twofold object. We have first a brief and interesting account of the naval captive balloon, with notes about its manipulation, "first aid" in connexion with accidents to the balloon or its attachments, meteorological notes, etc. This occupies 70 pages. The remaining 160 pages are devoted to "études beaucoup plus ardues," *i.e.* investigations of an engineering or mathematical character. This review must necessarily deal mainly with the latter.

First we have the theory of cables used with captive balloons, including the effect of wind. The author is clearly not a professional mathematician (it is to be hoped that non-mathematical readers will not misinterpret this remark), and the result is that he devotes a considerable amount of space in doing clumsily what can be done much more conveniently otherwise, and what indeed is fairly well known to such as have studied the forms of heavy chains. Interesting conclusions are reached when the wind is taken into account. The form is, of course, not that of the uniform catenary. If the weight is neglected M. Lafon gets a parabola with horizontal axis, as should be obvious *a priori* in view of the assumption made that the pressure of the wind is horizontal and proportional to the vertical projection of an element of cable. In general we have complicated curves (*not circles*, the author points out!), and it is of interest that the balloon can be in advance of the cable by the latter becoming vertical at some point below the balloon.

A topic to which the author directs special attention is one of tactics. The chief duty of the aerial scout is to give information as to the disposition of enemy ships. He must therefore observe, and this entails following an enemy ship at constant distance from it. We get the following problem in kinematics: A body moves in a given straight line (say) with given speed; a second body has given speed and is to move so as to be always at the same distance from the first: find the curve described by the second body. The author calls such a curve a "courbe encerclante"; he discusses the problem in great detail with tables and charts for the cases where the ratio of the speeds is 2 and 1·6 respectively. These and other matters form an interesting *mélange*, even if the author's claims to originality are occasionally rather feeble.

(4) The results of classical hydrodynamics are clearly not applicable to real problems, for obviously the statement that a sphere may move uniformly through a liquid without any resistance is at variance with the facts. Hence in the discussion of fluid resistance some departure from classical theory is required. Three main lines of departure have so far been suggested, and to some extent developed. In the theory of discontinuous fluid motion it is assumed that when a solid moves through a liquid there is a body of liquid behind the solid moving with it, while there is a surface of discontinuity separating this liquid from the remaining liquid where the motion is different at different points, and follows the laws of classical hydrodynamics. This theory has been developed in two dimensions by

Kirchhoff, Rayleigh, Mitchell, Greenhill, Levi-Civita, Cisotti, Villat, and others, while a suggestion for three-dimensional work on this theory has recently been made by Volterra. The second line of departure is the introduction of viscosity. The investigations made by Stokes have been extended by Rayleigh, Lamb, and others too numerous to mention, while the ideas of Oseen and his followers have led to interesting developments. Great promise attaches to the work of Bairstow and his assistants; a certain number of results have already been published.

The third line of departure from classical hydrodynamics is the subject of the present book by M. Roy. It is well known that d'Alembert's paradox, namely, that a body moving steadily through a frictionless liquid experiences zero resultant thrust, is true only if there is no circulation. When circulation exists we get a non-zero resultant thrust, as can be easily seen in the case of a circular cylinder. About twenty years ago a remarkable theorem was proved by Joukowsky, namely, that in two-dimensional steady motion there is a resultant thrust proportional to the density, to the relative velocity of stream and body, and to the circulation, in a direction perpendicular to the relative velocity: this thrust is quite independent of the shape of the cylindrical section.

It was very soon suggested that this theorem could be used to explain the remarkably high values of lift obtained with cambered aerofoils. As a matter of fact, similar suggestions were made on general lines by Lanchester in Great Britain, but his ideas were not followed up by any mathematical investigations. It was left to Kutta and others to apply mathematical analysis to this idea. At first artificial shapes were dealt with, like circular arcs, but during the last few years considerable progress has been made by a very active school of workers at Göttingen under the direction and inspiration of Prof. Prandtl—so much so that the theory is "popularly" known as the Prandtl theory. Considerable success has been obtained also by Glauert in England.

M. Roy gives a brief account of the method and of its chief applications, based on what is called the "linear theory," *i.e.* the theory in which the difference between the motions of any two particles of liquid is assumed small compared to the relative velocity between the liquid and the rigid barrier, so that only the first power of this difference is taken into account. The book is interesting and useful, but occasionally rather obscure, and difficult to understand. The main notion is, however, quite simple, and honours students in mathematics should certainly be introduced to it in preference to so many merely formal results included in orthodox courses on hydrodynamics. S. BRODETSKY.

Our Bookshelf.

Contributions to the Biology of the Rotifera. By Wesenberg-Lund. 1: The Males of the Rotif (Kgl. Danske Videnskabernes Selskabs Skrift Naturvidenskabelig og Mathematisk Afdeling, Række, IV. 3.) Pp. 191-345+15 plates. (Køb havn: Andr. Fred. Høst og Søn, 1923.) Kr. 21.2

As a result of more than twenty years' careful systematic observations carried out on the Rotifers numerous ponds in North and Middle Iceland, author of this important monograph has added grea to our knowledge of a very puzzling group of anim It was Ehrenberg who first clearly separated Rotifera from the Protozoa, with which they h previously been associated on account of their mic scopic size and general appearance, but he made serious error of regarding them as hermaphrodite, a it was not until 1848 that a male Rotifer was recogni as such by Brightwell. It is still commonly suppo that the males are very scarce, and until the appe ance of the work under review, males had been fou in little more than 100 out of the 1000 known spec This apparent scarcity is now shown to be due v largely to the fact that males are produced only certain periods of the year, but they may then app in enormous numbers. The ordinary method of production is by means of parthenogenetic eggs, l periodically, in some species once, in others tw a year—and only under favourable conditions— enormous increase in numbers takes place, and t "maximum" heralds the appearance of the ma from special male-producing eggs. They live only a few days at most and then disappear completely a almost simultaneously. The fertilised females prod the well-known "resting eggs," which always give r to females and inaugurate a new period of parthe genesis. The males of many species are still unkno but it seems probable that all give rise to males un suitable conditions.

It is interesting to observe that the author agr with de Beauchamp in considering the Rotifera to most nearly allied to the Turbellaria.

The work is accompanied by fifteen plates of excell figures, and the author is to be congratulated ve heartily on his interesting and valuable results.

Die Kolloidchemie als Hilfswissenschaft der Mineralo und Lagerstättenlehre und ihre Anwendung auf metasomatischen Blei-Zink-Lagerstätten. Von Dr. Bernauer. Pp. viii+83. (Berlin: Gebrüder Bo traeger, 1924.) 5*s*.

THE original object of this small work, as stated in t preface, was to inquire what part colloidal process and more particularly gel formation, played in me somatosis. Although the conception that ma minerals were gels had been systematically develop by Cornu, and had been adopted by Doelter and l collaborators, the author states that he could not fi anywhere a synopsis of the properties of mineral ge and therefore devotes the first part of the book to description of their characteristics and to the metho of diagnosis. The definition of a simple gel prepar *in vitro* is not easy, and does not become more so in t

ge of systems which may have undergone secondary transformations like re-crystallisation, so that diagnosis must rest on the simultaneous occurrence of a number of criteria. Due attention is given to a number of secondary phenomena, like fissures due to shrinkage, accidental double refraction, the influence of gels on crystal habitus, etc., which cumulatively point to a mineral having at some time passed through a gel stage.

The second part is devoted to the description and detailed investigation of metasomatic zinc-lead deposits, more particularly the well-known Wiesloch deposit, with especial attention to schalenblende and galena. Only the briefest summary of the author's conclusions is possible: he distinguishes three types of zinc sulphide, for at least two of which a gel may have been the original material, and three types of galena. The latter is always crystalline and the difference is one of habitus, which the author assumes to have been determined chiefly by the ratio of lead sulphide to zinc sulphide.

The book is an interesting example of the growing number of attempts to apply the results of colloid chemistry to the elucidation of natural phenomena, the direct imitation of which is unfortunately precluded chiefly by the time factor.

Kant's Treatment of Causality. By Dr. A. C. Ewing. Pp. viii + 243. (London: Kegan Paul and Co., Ltd., 1924.) 10*s.* 6*d.* net.

THE publication of Dr. Ewing's book followed upon its being accepted by the University of Oxford for the doctorate in philosophy. The plan of the work is twofold. In the first place, Dr. Ewing has written a work on one of the Categories of Kant in isolation from the whole, and, in the second place, he has endeavoured to elaborate and correct Kant in such a way as to present before the reader a restatement of Kant's proof in a form in which it can stand by itself and make a good claim on all schools of thought." The former plan, naturally, being less pretentious, is carried out with more success than the latter, although the author's strong insistence on certain fundamental aspects of causality may, on further elucidation, "work the trick."

As a student of Kant, the author shows gifts of understanding and knowledge which must be unique in so young a student, and his insistence on the metaphysical interpretation, as opposed to the merely psychological, in the transcendental deduction and the analogy, and his strong insistence on the teleological aspect of Kant's late works, show him to possess a mind which reads and criticises freshly and a firm belief in his own powers of interpretation. In this part of the work, all students of Kant will find real interest and fresh enlightenment. We fear, however, that his hope that Kant can be restated in such a way as to prove causality is rather sanguine, and we are unable to follow his startling contention that we have direct synthetic *a priori* knowledge in some of our psychic states. His insistence on the "must" in causal laws will also draw protest from certain schools of thought, although it is time that the necessity was again pointed out, and we are glad that Dr. Ewing has had the courage to do it. The work can be thoroughly recommended to all students of philosophy.

Behind and Before: Two Essays on the Relation of History, Politics and Eugenist Warnings. By W. E. Heitland. Pp. xv + 166. (Cambridge: At the University Press, 1924.) 6*s.* net.

MR. HEITLAND, of St. John's College, Cambridge, has written a short but very thoughtful and suggestive book, mainly on the question of how far we may argue from history as to our action in the present and its results in the future. In general, he admits the possibility, and then proceeds to enforce the urgency of the study. But the bulk of his essay suggests various cautions and raises numerous problems. In particular he emphasises the need of distinguishing the behaviour of mankind in masses and groups from that of the same persons taken as individuals. This is, of course, the fundamental principle, in fact the *raison d'être*, of sociology. He also holds that if lessons are to be learnt from history as an equipment for practical politics, it is in the experience of recent times that they must be chiefly sought. This again is now a dominant principle in the school teaching of history, and it is thought by many people that the pendulum has swung too far in the direction of modernity.

There is no main thesis in the book which the author is concerned to defend as a new gospel, but he inspires a salutary sense of the importance of social biological study and drops many wise hints on the way. "A searching test," he tells us, "of the soundness of our civilisation is the frank and loyal acceptance of the consequences of our own imperfection." He is emphatic on the need of leadership, but avoids the common eugenic fallacy that the good stocks, which should naturally lead, are being bred out and swamped by inferior material. "What evidence is there," he asks, "that men risen from the ranks do lower the moral of the governing class?" Do not their better elements produce citizens of high quality, sometimes of distinguished merit? Do not they add strength to the governing classes? And where did these upper classes come from? A very interesting and well-balanced book. F. S. M.

The Nature of Art: an Open Letter to the Professor of Poetry in the University of Oxford. By Prof. J. A. Smith. Pp. 32. (Oxford: Clarendon Press; London: Oxford University Press, 1924.) 2*s.* net.

PROF. SMITH'S Open Letter is one of those delightful attempts to place before a brother professor a little of the knowledge which, although belonging more properly to the sphere of the writer's particular branch of learning, ought to be shared by his confrère. The letter was not written for publication, and, for that reason, is all the more delectable, for it shows a spirit of true learning, willing co-operation, and kindly friendliness which, in these days of commercial antagonism, is all the more refreshing. The preface tells us that after a discussion with the professor of poetry at Oxford, Prof. Smith desired further to explain his own position with regard to the nature of poetry and art and took the opportunity of doing so in this letter. That we have the privilege of reading it is due, apparently, to the impression that the letter made on the recipient. We do not know whether the sender made a convert, but the present writer, for one, is heartily

glad that the letter has been published. The aim of the letter is primarily to explain the theory of art which Prof. Smith himself holds. He points out that any criticism of art requires a ground for criticism, and that this, again, requires a theory. The writer holds such a theory and begs leave to present it to his friend. The theory is not his own, but that of a master, but he holds it none the less sincerely for that and hopes that it is, first, intelligible and, secondly, acceptable. The theory is, of course, that of Gentile, and the letter is a clear exposition of the Italian master's views on art. This we refrain from criticising, but we admire and commend both the matter of the letter and the spirit which prompted the writing of it. Those who have any interest, either in letters or art, will thoroughly enjoy the reading of it.

An Introduction to the Study of Heredity. By Prof. E. W. MacBride. (Home University Library of Modern Knowledge.) Pp. 256. (London: Williams and Norgate; New York: H. Holt and Co., 1924.) 2*s.* 6*d.* net.

OUR knowledge of heredity has long since passed the stage when it could be summed up in a few simple aphorisms such as "like begets like." During the past thirty years especially, many diverse lines of approach have been explored; biometry has attempted the measurement of likeness, cytology and experimental embryology have unveiled some of the mysteries of begetting, and Mendelian research has given one answer to the question why like sometimes begets unlike. To sketch an intelligible outline of the results obtained in these varied fields and to present them in ordered and logical sequence is no light undertaking; to compress it within the space of 250 pages might well seem impossible. Prof. MacBride, however, is an experienced teacher, with a gift for lucid and forcible exposition, and this little book is well fitted to arouse interest and to stimulate the reader to further study.

In such a survey it is impossible, even if it were desirable, to avoid some degree of dogmatism, and Prof. MacBride maintains his own point of view with vigour and occasionally with a touch of asperity. Some may think that he gives too easy credence to the claims of the Vienna school, or that he overestimates the adequacy of Tornier's hypothesis of "germ weakening" to account for the origin of mutations, and specialists in various fields will doubtless detect minor inaccuracies. It is a little difficult to reconcile the statement on the last page, "The study of biology teaches unequivocally that all progress in the animal world has been brought about by natural selection," with the tenor of some earlier passages, notably on page 138.

Entdeckte Verborgenheiten aus dem Alltagsgetriebe des Mikrokosmos. Von Prof. Dr. Paul Lindner. Pp. viii+291. (Berlin: Paul Parey, 1923.) 6*s.*

PROF. LINDNER'S book is a comprehensive treatise on a great variety of sciences that require the microscope as their principal instrument of research. It deals in a discursive way with the structure of the eye, the history of the microscope, the manufacture of leather, the brewing of beer, as well as with the biology of t common microscopic animals and plants, and wi many other topics. As might be expected in a bo of such wide scope, the quality and treatment of the subjects dealt with is not consistently good. Ma readers will be glad to have in a convenient abbreviat form the results of the distinguished author's searches on the fermentation processes, and the chapt dealing with the biology of wine making, of brewin on the bacterial decomposition of the food in t alimentary canal, on the formation of honey dew, a many other examples of interesting symbiotic relatio between animals and plants, are all excellent.

In other chapters the information given in the te is not trustworthy. The larvæ of the ox warble are not transferred from the legs to the œsophagus the tongue as stated on p. 259, but, as proved Carpenter, penetrate the skin and find a passa through the tissues to the alimentary canal. T principal cause of infestation by miners' worms (A chylostoma) is not by drinking polluted water. T names of some of the most prevalent parasites ar pests need revision. There is no justification, example, for the retention of *Distomum hæmatobiu* and *Musca vomitoria*, for the Bilharzia parasite and t blow-fly respectively. Many of the figures in the te are so small and so badly printed that they are mi leading instead of helpful to the reader.

Ordnance Survey Professional Papers. New Serie No. 7. *Air Survey and Archæology.* By O. G. Crawford. Pp. 39+13 plates, 5 diagrams+2 map (Southampton: Ordnance Survey Office; Londor H.M. Stationery Office.) 5*s.* net.

IN recent years field archæology has received a unexpected but very valuable addition to its apparat of investigation, in the shape of air-photography. suitable country, especially in the down land of southe England, we can look through the veil of the past an see on the air-photographs the dim traces of a lon vanished race; we can detect the lines of fiel boundaries and lynchets, of roads and earthwork all invisible to an observer on the ground. It is show by Mr. Crawford, in the volume before us, that n only can the features above indicated very often discovered by means of photography, but also tha it is possible to draw from the photographs importa inferences as to the relative ages of the earthwork Mr. Crawford deals particularly with the period Celtic occupation of England, which may, in his opinio have begun about 450 B.C., and, no doubt, lasted unt the final disappearance of the Romans about A.D. 45 An examination of the air-photographs shows a networ of field boundaries, banks and roads associated wit upland villages; some of these were certainly existence at the coming of the Romans, and som certainly persisted until their departure.

All who are interested in the history of rural Englan during this long period of some thousand years wi find this publication well worth studying; it is admi ably produced and illustrated, and incidentally show the reconstruction, from air-photographs, of th eastern branch of the Stonehenge Avenue leading dow to the river Avon.

Power Station Efficiency Control: a Treatise for the Power Station Engineer on Boiler-Room Efficiency, Turbine-Room Efficiency, Heat Balance Control, Methods of Recording and Tabulating Operating Results and Keeping a Day to Day Check on Operating Efficiency. By John Bruce. With an Appendix by R. H. Parsons. Pp. xiii+244. (London: Sir Isaac Pitman and Sons, Ltd., 1924.) 12*s.* 6*d.* net.

In the management of the boiler-house of power stations, great improvements have been made in recent years, with a consequent increase in the over-all efficiency of generation. All the coal used is now weighed with high accuracy. The temperature of the furnaces and of the flue gases is recorded and chemical analyses of the products of combustion are continually being made. The results are recorded, tabulated, and suitably analysed. The staff are always striving to improve their methods and are always ready to consider the possibilities of new inventions and of new fuels. Six years ago, the ratio of the heat equivalent of the kilowatts generated to the heat equivalent of the fuel consumed was commonly only about 10 per cent. To-day, thanks to scientific investigations, there are power stations in various places with a thermal efficiency of more than 18 per cent. Most of the improvement is due to increased efficiency in the boiler-house. The author asks the reader to look on this book as addressed to power station operating engineers, and states that it is not a highly technical treatise but a general talk on the salient factors influencing efficient operation. We can recommend the book to both students and engineers, as it gives a good introduction to many problems which engineers are successfully solving.

The Microscope. Part 2. An Advanced Handbook: a Sequel to "The Microscope, a Simple Handbook." By Conrad Beck. Pp. 231. (London: R. and J. Beck, Ltd., 1924.) n.p.

This book may be regarded as an advanced supplement to the author's simple handbook on the microscope, already noticed in these columns. It deals in particular with the optical theory of the microscope and on somewhat novel lines. What we would especially commend is the manner in which the reader is carried on from point to point with the use of simple geometrical diagrams and without reference to advanced mathematics.

In addition to the general optics of lenses, excellent chapters are introduced on microscopic photometry, resolution, and illumination. In the last named, dark ground illumination is dealt with and details are given of the Barnard special illuminator which permits of the use of objectives up to 1·27 N.A. In Chapter viii. various microscopes for special purposes are described, *e.g.* measuring, tank, dissecting, and research, also the Barnard appliance for testing rigidity by an interferometer method. The final chapter deals with polarised light and its various applications to the microscope.

The book is one to be recommended to the non-mathematical reader who desires to understand the optical theory of the microscope. Where Mr. Beck expresses views somewhat different from those current, he at least supports them with reasoned explanations and experiments.

Elements of Electrical Design. By Prof. Alfred Still. Pp. xxi+535. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 25*s.* net.

Many problems connected with the design of electrical machines and apparatus are discussed in this volume. It is shown that in many cases sufficiently accurate solutions can be found by applying elementary mathematics and known physical laws. When designing high-voltage insulators, the reader is shown how to picture for himself the tubes of electrostatic induction in the insulator and the surrounding space, and when studying the action of electric generators and motors he pictures the conductors as cutting the magnetic flux. A concrete mental conception can thus be obtained of the actions which produce easily measurable results. The author points out that the difference between a laboratory course and a course in machine design is that the former is mainly concerned with analysis, separating out the losses in a machine, whilst the latter is concerned with synthesis, the building up of a machine. A course in design is a link between academic studies and practical engineering. It helps to develop engineering judgment, the student learning the relative importance of the many factors which enter into a commercial problem.

A First Chemistry for Schools. By W. H. Hewitt and S. T. E. Dark. Pp. viii+316. (London: Methuen and Co., Ltd., 1924.) 5*s.*

This book consists mainly of directions for the carrying out of a large number of experiments by a class of boys. The results when discussed in class should provide excellent material on which to build a sound structure, though more discussion in the text would be welcome. Our curiosity, which is aroused on p. 28 by a reference to the "chemist's definition" of acids in Chapter ix., is unfortunately not satisfied, and the laws of chemical combination are dealt with somewhat casually in a chapter headed "Reduction, Oxidation." The book contains some good features, for example, hints on keeping a note-book, though the practice of copying original readings into a best note-book is to be deplored. Molecules are discussed before atoms. This unusual method of approaching what is probably the most difficult part of the subject for beginners is sound, but the necessity for using two distinct units is not clearly brought out, and some confusion may arise as to the difference between the "ultimate" particles called molecules and the "indivisible" particles called atoms.

I principî della meccanica alla luce della critica. By Giuseppe Casazza. Pp. 174. (Roma, Milano and Napoli: Albrighi, Segati and C., 1921.) n.p.

"A new assault upon the rock of crystallised ideas of the nature of force" is what the author claims for this book. One or two headings will suffice to show how weak are his conceptions and poor his standards of scientific value: "Carnot's Cycle (or the prettiest cycle of nonsense or contrasense that can be imagined)," "Astronomical Mechanics (or the greatest scientific joke that has ever appeared under the heavens)," "The Principle of Relativity (or a comedy full of laughter)." S. B.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Earth Tides, Ocean Tides, and Local Geology.

IT was a source of satisfaction to me to read Dr. J. W. Evans's letter in NATURE of July 12, p. 49, and to note that he recognises the importance of a further study of earth tides. I quite agree with him in thinking that more earth-tide work is likely to be done if seismographic apparatus is adapted to that purpose than if observations are made only with an apparatus of the Michelson-Gale type, or with other apparatus equally refined and specialised. The results that can be obtained with seismographic instruments seem to me well worth having, even if the curves do not show the beautiful smoothness of those of the Michelson-Gale apparatus.

I am obliged, however, to differ with Dr. Evans, for reasons presently to be stated, in regard to the importance which he assigns to the local geology as a cause of anomalous results. Although our knowledge of the tides at sea and our command of mathematical methods are not sufficient for a rigorous computation of the effects of ocean tides on earth tides of like period, nevertheless they are sufficient not only to estimate the order of magnitude of these effects, but also to determine roughly their amount. It thus appears that the effects of the ocean tides are large enough to explain the observed anomalies in the earth tides, and that, in the cases treated by the Japanese investigators cited in my communication to NATURE of June 21 (vol. 113, p. 889), they do explain the anomalies quite as well as the inaccuracies of the method would allow one to expect. Furthermore, the influence of the local geology, although it must exist, is easily seen to be small. The French phrase for earth tides, *marées de l'écorce terrestre*, might seem to imply that earth tides are essentially a crustal phenomenon. Of course, we can observe only in or near the surface of the crust, but the tidal forces extend down to the centre of the earth, and, unless the matter of which the earth is composed is absolutely rigid, the tidal yielding must extend down to the centre also.

We may conceive the earth as divided into concentric spheroidal shells, and we may further suppose that the outermost shell is so thick that within it local geological differences die out, and that every shell within is homogeneous. The tide-producing force is a body force, acting on each particle of matter. Each shell receives the tidal distortion due to all the shells within it, and adds a small contribution of its own.[1] The tidal distortion of the outermost shell is mainly what it receives from the shells within, for we assume that the hypothetical shells never lose contact with one another. They are formed by mere hypothetical boundaries which we insert for our own convenience into a continuous body. The yielding of different parts of the outermost shell to tidal forces must be somewhat different, corresponding to local geologic and geographic conditions, but this difference must be decidedly small in comparison with the whole distortion accumulated from the centre outward.

In the preceding paragraphs the earth tides proper alone have been considered, not the secondary effects of ocean tides of like period. In respect to latter, the local geologic conditions might be of m importance than in respect to the primary earth tid for the ocean tides exert a surface pressure, no body force acting from centre to surface like th which causes the primary earth tides. Even he however, the effect of local conditions is proba not important, for the secondary effect of the ocea tides becomes large only when the oceanic tide, th is, the surface pressure, is in approximately the sa phase over large tracts of ocean. But when pressure is applied over a large area it goes de that is, a considerable depth must be attained bef the effects of surface pressure become small in co parison with the values at the surface. In th going deep the pressure involves portions of str that presumably are nearly alike all over the ea and depend but little for their properties on t geology and geography of the portions of the out most stratum directly above them. The earth tid show the effect of the yielding of the earth as a whc and to this the outer crust will generally contrib but a small part.

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The Resonance Theory of Hearing.

IT is surprising that the resonance theory hearing continues to be revived in one form another. As soon as the ear is considered in relati to the other sense organs, it becomes apparent th all forms of resonance theory are profoundly u satisfactory and unphysiological.

In the course of evolution the hearing apparat derives from the tactile sense. In primitive fishes have the organs of the lateral line. One of the placed at the cephalic end, becomes invaginated form the otic vesicle, which develops into the co plicated membranous labyrinth. At first, the sens tions are purely tactile, being shocks transmitt through the watery medium. When the surroundi medium becomes air, and the vibrations assume periodic character, these are registered in the cochl —a derivation of the otic vesicle—and perceived sound. Why is the ear alone of all sense orga credited with the capacity for analysing the particul stimulus to which it is adapted to react? We do n claim this faculty for other organs. The reti perceives white light and does not analyse this in its component spectrum. If there are any analysi structures in the fundus of the eye, these are a mittedly scattered all over the retina. The skin, is true, possesses separate end organs for the sens tions of pressure, pain, cold, and heat. But who h ever imagined one end organ which will register s 40° C., and that particular temperature only, whi another registers 45°? Yet it is an apposition of series of such separately functioning end organs the cochlea that the supporters of the resonan theory ask us to accept.

The analogy which compares the fibres of th basilar membrane to piano strings continues appear in all the text-books of physiology. continuous, very small, spread-out membrane, varyir in width from the base upwards in the proportio of approximately 1 and 10, is supposed to contain series of end organs which must number at least 200 Each is delicately attuned to vibrate in sympath with one periodic vibration only. This marvello collection of resonators must be fully developed birth. It must remain unchanged throughout lif from the moment a baby picks up sounds unt

[1] The outer shells, of course, react on the inner shells, which therefore behave differently from what they would if the outer shells were absent.

leth at a ripe old age, while every other structure n he body is subject to the laws of growth and leeneration. Helmholtz himself at first thought ht the external pillars of the organ of Corti were h resonators. When it was shown that these do d exist in birds, which have particularly acute nering, he abandoned the external pillars in favour of he fibres of the basilar membrane. Nearly every ter structure of the cochlea (*e.g.* the tectorial mbrane, the hairlets) has at one time or another en credited with the functions of resonator. As Bonnier, in his work "L'Audition," so forcibly expresses t "pendant plus de deux siècles on tortura pour st [the resonance theory] l'anatomie, la physique, l'périmentation et la clinique."

No theory of hearing will be satisfactory unless it sarts with the assumption that the cochlea *as a wole* responds to sound vibrations. Each sound pture will create a pattern and make a composite ıpression in the cochlea, just as each visual im-pssion leaves a composite impression or picture on th retina. Examples of very interesting theories, blt up on these lines, are those of Wrightson and Fith, and that evolved by Bonnier. The ear is no nre an analysing apparatus than the blackened dm which registers the vibrations of a tuning-fork.

J. Keen.

Leicester, September 27.

Organ-Pipes of Unusual Shapes.

The work of Principal J. A. Aldis (Nature, Aug. 30, p 309) on the Bicylindron is not only of practical importance to the scientific pipe-builder, but also constitutes an important addition to the acoustical theory of the organ-pipe. The Bicylindron as invented by Mr. Aldis is new to organ-practice, but there has existed for several hundred years a form of pipe, the theory of which is similar to that of the Bicylindron, although differing greatly in its solution. I refer to the Rohrflöte or Flûte à Cheminée (a particular case of which is found also in the Flauto d'Amore), the invention of which may probably be claimed by the German organ-builders of the seventeenth century. It was found that a stopped pipe of medium scale could be given a very beautiful smoothness of tone if the stopper were perforated by a narrow cylindrical hole, coaxial with the pipe. In old German organs the four-foot stopped diapason in wood was sometimes treated in this way, thereby replacing the rather nasal stopped diapason quality by one more desirable in a small organ. Later, the perforation was extended to metal pipes, a particular form known as the Rohrflöte being constructed, which owed its peculiar ringing quality to the extension of the main body of the pipe in a short narrow "chimney," and to the provision of a semicircular mouth with large ears, which enable the pipe to be tuned exactly.

The theory of the Rohrflöte was mathematically established by Dr. Robert Gerhardt in 1884.[1] Since this treatise is inaccessible to me, and I can find no adequate summary of his work, I have attempted the investigation with the following results, which I hope may one possessing Dr. Gerhardt's work will correct if his results and mine are at variance. The Rohrflöte is obviously a Bicylindron of which both pipes are open, and the one of larger diameter contains the mouth. The solution is, therefore, markedly different from that of Mr. Aldis. But in both cases the displacement is discontinuous at the plane joining the two tubes, although the differential coefficient of the displacement, with respect to measurement along the axis of the pipe, is continuous at that plane. Using the same treatment as that used for the Bicylindron, the solution for the Rohrflöte is

$$\frac{\tan mh}{\tan mk} = -\frac{r^2}{R^2},$$

where $m = 2\pi/\lambda$, λ being the wave-length of the resultant fundamental vibration, and h and k the speaking lengths, and r and R the radii of cross-section of the chimney and body respectively. If $r/R = \tan \pi/n$, a series of upper partials will be obtained, given by

$$1,\ n-1,\ n+1,\ 2n-1,\ 2n+1,\ \ldots \text{ etc.}$$

Even if "n" is not an integer, and the upper partials consequently inharmonic, their difference tones will give the octave of the fundamental, and hence the effect may not be altogether displeasing.

The solution of the equation has certain points of interest. If $k = qh$, the fundamental frequency will be $2q/n$ times that given by the body of the pipe, without a chimney, when closed. For particular examples one can use the expanded form of the relation:

$$-\frac{R^2}{r^2} = \frac{q - qC_3 \tan^2 mh + qC_5 \tan^4 mh - \ldots}{1 - qC_2 \tan^2 mh + qC_4 \tan^4 mh - \ldots}.$$

The equation may also be written:

$$\left(1 + \frac{r^2}{R^2}\right) \sin (1+q)mh = \left(1 - \frac{r^2}{R^2}\right) \sin (q-1)mh,$$

which, by taking the cases $q = 1$ and $r^2/R^2 = 1$, demonstrates the correctness of the expression. If for convenience we put $r^2/R^2 = w$, we are only concerned here with values of w between 0 and 1, although the equation would also serve for $w > 1$. Taking these limits into consideration, it is easily seen that $\left[\frac{\partial m}{\partial h}\right]_{w,k}$ is negative while $\left[\frac{\partial m}{\partial w}\right]_{h,k}$ is positive. This is in agreement with Dr. Audsley's statement that "if the diameter of the chimney be retained, the lengthening of it flattens the pitch of the pipe; while, on the other hand, if the length is retained and the diameter of the chimney is increased, the pitch is sharpened."[2]

It can also be shown that for any value of q, n may only vary between two definite limits if w varies from 0 to 1. When $q = 2$, n must lie between 3 and 4. When $q = 3$, n may vary from 4 to 6; and when $q = 4$, n may have values from 5 to 8·03. The region of possible values of n, therefore, increases in magnitude as q increases, and the mean value of n rises as q increases. The most desirable values of n are 5 and 7 for the Rohrflöte, and these can be obtained if the length of the chimney is between a third and a quarter of the length of the body of the pipe. This is not entirely in agreement with practice. Dom Bedos gives the design of a pipe in which the chimney is exactly one-third the diameter and one-half the length of the body. From the above theory this would give $n = 3{\cdot}75$, with a series of partials not very pleasing to the ear. But Dr. Audsley recommends a shorter chimney, as he considers the quality of the stop seriously impaired by the use of chimneys more than half the length of the body. "Let the chimneys be one-fourth the diameters of the respective bodies and from one-third to one-half the speaking lengths of the bodies, according to the quality of tone desired." This is very well supported by the theory. But from

[1] "Nova Acta der Kgl. Leop.-Carol-Deutschen Akademie der Naturforscher." Band XLVII., No. 1. Halle, 1884.

[2] "The Organ of the Twentieth Century." (London, 1919. Sampson Low, Marston and Co.)

the simple theory the best pipe of all would be one having the chimney one-fourth the length of the body and 0·337 of its diameter. The resulting series would be

1, 6, 8, 13, 15, 20, 22 . . .,

that is, $n=7$, with a fundamental frequency of 1½, that given by the body of the pipe, without a chimney, when closed. The tone of such a pipe would be very smooth, with a gentle ringing quality, and none of the open diapason richness given by the octave, twelfth, and double octave, and also none of the dull nasal quality exhibited by the closed diapason when the odd harmonics are present in excess.

The theory, moreover, offers an explanation of a phenomenon which puzzled organ-builders greatly on its discovery. It was found that if the chimney was turned inwards, and faced downwards instead of projecting outside the body of the pipe, neither pitch nor quality was altered. An examination of the formula shows that this would be so, the stationary vibration in the chimney being then composite.

We must also realise that the simple theory must be modified by the introduction of the end-corrections required at the mouth of the pipe and at the upper open end of the chimney. The correction at the mouth is large and amounts to nearly twice the depth if the pipe is of rectangular section (Brillouin), or three and a third times its radius if cylindrical (Cavaillé-Coll). In the case of the Rohrflöte, the correction is increased by the presence of the ears. The correction required at the upper end of the chimney is of unknown magnitude, although it would probably be proportional to the radius of cross-section of the chimney. The difficulty lies in the experimental fact that very little sound indeed is propagated from the open end of an open labial pipe, if the mouth is of the simple bay-leaf type and not inverted. Hence the open-end correction, which is required by the transmission of stationary vibration to spherical propagation, may be imaginary in this case. If, however, the mouthpiece of the pipe were removed and resonance determined by tuning-forks, both open ends would require a correction as given by Lord Rayleigh's formula.

Enough has perhaps been said to indicate the interest of the problem and how well worthy it would be of careful experimental investigation.

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A Sidelight on Bird Migration.

IT is usually accepted as an axiom of ornithology that the annual migration of birds consists of a movement from winter-quarters to breeding-quarters and back. The following notes, taken from observations made by me during the last five years on the North-west Frontier of India, may suggest that this view of migration does not entirely cover every case.

The crested lark (*Galerita cristata*) and the common pied bush-chat (*Pratincola caprata*) appear to come to the Peshawar valley to breed, and, at any rate in some cases, to leave the valley as soon as their young are able to fly, and spend the hottest months in the nearest hills. Between the end of August and the middle of September both species return to the valley. The movements of the two species are not identical, and must therefore be described separately.

Crested larks may be seen in the Peshawar valley at all seasons. During the winter months they congregate in small flocks. About the beginning of March the number of flocks begin to increase. By the end of the month most of them have paired, and during the first few days of April the number of la seems to decrease. During April the eggs of t species may be found in every field and on every pi of waste ground. The earliest date on which I h found a nest containing eggs in this district is Apri and the latest April 29. By the end of May, cres larks have become scarcer in the valley than they at any other season. This scarcity continues u about the end of August, when the numbers ag greatly increase. About the middle of October slight decrease again takes place, after which th appear to remain constant until the cycle of mo ment recommences in March.

No common pied bush-chats appear to remain the Peshawar valley for the winter. The earliest d on which I have noted the appearance of this spec is Feb. 28. The majority of this species seem to l in April. The earliest date on which I have fou a nest of this species containing eggs is April 7, a the latest (except for two nests containing hatchi eggs found on July 11, 1922) is May 17. By far t majority of eggs are laid during the second and th weeks of April. By the end of May, bush-chats, li the larks, become scarce in the valley, about t middle of September their numbers again increa and soon after they leave for the winter. The lat date on which I have observed them is Oct. 1.

During the summer months, when crested lar and pied bush-chats become scarce in the Peshaw valley itself, their numbers undergo a considera increase on the hillsides below Cherat, at elevatio varying from two thousand to three thousand f above the general level of the valley. The lar proportion of young birds to be seen on these hillsid at this time is very striking, and one is almost irresi ibly led to the conclusion that these two species, li the human inhabitants of Peshawar, have taken th families to the hills.

From the foregoing observations the following t deductions are, perhaps, permissible:

First: that the common pied bush-chat, comi from somewhere "down country," breeds in t Peshawar valley, spends, in a great number of cas the hottest months in the hills, and returns to wint quarters through the Peshawar valley.

Secondly: that some of those crested larks th breed in the Peshawar valley also go to the hills f three or four months after breeding.

If this is a true reading of the facts, is it not possib that other species of birds also may migrate betwe three localities instead of the more usual two? T matter would bear the attention of all observers birds.

F. S. BRIGGS.

Peshawar, India.

Rockets and High Altitude Research.

A RECENT book review in NATURE for August 2 1924, page 270, of Herr Oberth's "Die Rakete den Planetenräumen," 1923, calls for a brief commen

Following the tone of the book, Oberth is credit with being more ambitious than the writer of th comment, in suggesting the construction of a rock large enough to carry passengers, even to the distanc of the planets, whereas my main object is present as the sending of a rocket to the moon, propelled b successive charges of nitrocellulose.

I first became seriously interested in the gener problem of high altitude research in 1899, and 1907 I submitted, *for publication*, an article discussi the use of heat for expelling material at a hi velocity, in order to furnish a propulsive force sufficie to permit navigation of interplanetary space.

The idea of using hydrogen and oxygen in multip

rckets was conceived in 1909; the general theory w put in satisfactory form in 1912; and the use o these substances mentioned in Smithsonian Miscellaneous Collections, Vol. 71, No. 2, for 1919. Oberth, on the other hand, claims in his book to have rde his first finished plan of a rocket to use wet gu-cotton in 1909, and to have drawn up his first pn of an hydrogen-oxygen rocket in 1912.

Further, as to the use of liquid propellants and ctinuous combustion, these were suggested by m, *by publication*, in 1914, and were *tested experimtally* in 1921, the development carried on under r direction since that time having been confined eirely to rockets of this type.

t may be mentioned here that a request was reived from Herr Oberth, dated May 3, 1922, sting that he had been working for some years o the problem of passing over the atmosphere of th earth, and requesting me to send any books I ght have on the subject. Compliance was made b sending a copy of the above Smithsonian publicatn; and a copy of Herr Oberth's monograph, wich incidentally deals with theory rather than with eperiments performed, was received on July 19, 1923.

As to the idea of a passenger-carrying rocket, al the reaching of planetary distances, it is only fir to say that, while I have considered these matters wh much care, and have gone so far as to make laoratory tests to check my conclusions, I am now, al always have been, only too well aware of the cnservatism of the average person regarding new aplications of physics. Thus, because it has been m desire to make actual progress and to conduct a:ual experiments, I have endeavoured, so far as pssible, to focus attention on the problems that l immediately ahead, the first of which is an explorath of the earth's atmosphere, and have restricted te discussion of certain sensational, but nevertheless ieresting and realisable, matters to confidential rports.

R. H. Goddard.

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Worcester, Massachusetts, U.S.A.

Ive- (and Six)-Point Support: "Right as a Trivet."

As practical problems are usually a function of several variables, individual opinions are determined l the order of importance attached to the variables. he more numerous the conditions, the truer becomes le old expression, "Quot homines tot sententiae."

If in this question of fits we place pure mathematical d geometrical principles first, we have one point of iew. As there are others which I think largely ctermine the workshop attitude and possibly the 'Enfield Tradition," I should like to refer to some of em very briefly; to do so fully is not possible in a :ter.

Let us consider the example from Thomson and ait quoted by Sir George Greenhill in his letter i Nature of September 27. It is stated therein at "the rifle may be replaced any number of mes in precisely the same position." If much curacy is demanded, that statement is not correct, cause the materials at the points of support, where e forces of impact may be considerable, swage or ear away and quickly so when the parts are handled they must be in the workshop.

In designing our apparatus we must consider the ysical properties of the materials as well as the ometrical principles involved. The materials dermine the areas over which the loads must be stributed and, if they cannot be approximately oints, what value are we to attach to the principles f geometrical fits?

To demonstrate the practical application of these principles Thomson and Tait selected a bad example; as in the case of a rifle the convex abutments cannot be placed in their more proper geometrical position within the bore. Suppose a cylinder mounted in the manner described has longitudinal freedom and is constrained transversely: the slightest bend of the cylinder under its own weight, or by the action of the sun on one side of it, may destroy the longitudinal freedom, as the circular section of the fixed abutments must then accommodate an elliptic section of the piece.

The geometrical principle is based on the assumption that *all* the parts involved are absolutely rigid. We practical men, whose business it is to understand the limitations of materials, dare make no such assumption. In the workshop most of us are thoroughly familiar with geometrical principles. We were taught them in the universities and colleges. If we do not slavishly adopt them, it is generally with good reasons.

There has been within the past few years a good deal of adverse criticism of the practical trial-and-error type of man in industry, the articles having usually for their text "The Neglect of Science by Industry." If the writers of these articles were better informed, I feel sure they would find the converse text "The Neglect of Industry by Science" a more appropriate one.

James W. French.

Anniesland, Glasgow, W.2,
October 7.

Fine Structures in Non-Hydrogenic Atoms.[1]

For some months we have been studying the data on fine structures of the lines of non-hydrogenic atoms. These fine structures arise, in every case so far studied, from transitions between the components of complex spectral levels. Save for a few isolated examples, it can be readily proved that fine structures are not due to isotopy. (See Scientific Paper No. 490 of the Bureau of Standards.)

It is necessary in certain cases to introduce a *fine quantum number f*, the values of which characterise the different components of a complex level. In some elements, a selection principle for this quantum number makes its presence felt, and the separations of the components are in integral ratios. So far, attempts to establish intensity rules have failed, but this part of the work is not finished.

Nagaoka, Sugiura, and Mishima (*Jap. Jour. of Physics*, 2, 121, 1923) have published measurements of mercury fine structures which are precise to almost 10^{-4} A. These data have enabled us to analyse successfully the complicated fine structures of nearly all the mercury lines they studied.

The phenomena of fine structures are so diverse that we cannot hope to have a unified physical explanation for them. In isolated cases, such as the 4_4 terms of Al^+ studied by Paschen, they may be due to relativity. In other cases, the components of a complex level behave like a tiny multiplet, and the structure may depend on magnetism for its origin. In other cases, magnetic fields do not affect the fine structures, and we must look to unknown dynamical peculiarities of the individual element for an explanation.

A paper covering the whole field will soon be published.

Arthur E. Ruark.
F. L. Mohler.
R. L. Chenault.

Bureau of Standards,
Washington, D.C., U.S.A.,
August 23.

[1] Published by permission of the Director, Bureau of Standards, of the U.S. Department of Commerce.

The Shrinkage of Gelatine.

IN the *Kolloid-Zeitschrift* for August my friend Mr. Emil Hatschek describes some beautiful and symmetrical figures which result from the slow drying and consequent shrinkage of variously shaped blocks of gelatine. A squat cylinder shrinks into a biconcave disc with deeply grooved periphery; a cube becomes a beautiful stellate figure, with apices corresponding to the eight corners of the cube, and with sides which sag in towards a more or less cubical central hollow. The former case shows a striking resemblance to a simple vertebra, such as that of a cartilaginous fish; and it is very curious to see how so simple a phenomenon as shrinkage converts a cylindrical block into the form of an "amphicœlous" vertebra.

For the moment, however, I am less concerned with biological analogies than with what I believe to be a simple general explanation of these "shrinkage-figures." In one of Plateau's experiments, we take two parallel hoops of wire (within certain limits of distance apart), blow a soap-bubble between them, and then gradually exhaust the bubble; we thereby obtain a figure bounded above and below by concave spherical surfaces, and surrounded by a peripheral groove which is a portion of a catenoid. Again, if we dip a skeleton-cube of wire into soap-solution, films run inwards from the twelve sides in such a way that the common edge of three films meets either each corner of a plane quadrilateral fenestra, or each corner of a little central cube; the latter is the more symmetrical figure of the two, but in each case a figure *minimæ areæ* is realised, automatically and instantaneously.

The two gelatine shrinkage-figures which I have mentioned are nothing more nor less than *approximations* to these minimal configurations. The corners and edges of the gelatine block are the first parts to show shrinkage, for here the surface for evaporation has the highest ratio to the content within; thus edges and corners become rigid in comparison with the rest, and form (as it were) a framework for the whole mass. Bounded by this skeletal framework the mass of gelatine shrinks away; and its surfaces tend to realise, slowly and imperfectly, the self-same minimal-surface configurations which the soap-film achieves in immediate perfection. The actual curved surfaces of the shrinking cube are very beautiful: I take them to be conformal transformations between the original plane side of the cube and the square truncated pyramid which the four films on each side bound, as they pass from the outer skeleton to the little central cube; but the full elucidation of these surfaces is a job for the mathematician.

Only in small particulars, easy of explanation, do the actual shrinkage-figures differ from the above description. The shrinking edges and corners are not lines or points but graded areas, and the subsequent form of the curved surfaces is somewhat complicated thereby. Again, while the edges tend to become rigid, they do so imperfectly; they act not precisely as do the wire edges of our skeleton-cube, but rather as these would do were they replaced by threads. That is to say, the edges themselves tend to sag inwards, and do so, doubtless, in circular arcs. A minor point, to which Mr. Hatschek has directed attention, is that at first the sides of the several figures bulge slightly outwards—they show a temporary convexity before they become concave. This is simply due to the fact that the edges of the figure contract perceptibly before the whole volume is materially reduced.

D'ARCY W. THOMPSON.

St. Andrews, October 4.

Microseisms associated with the Incidence of t South-west Monsoon.

THE late Dr. Klotz was the first to suggest relationship between disturbed weather in the No Atlantic and the largest microseismic moveme at Ottawa. The microseisms recorded by the Mil Shaw seismograph at the Colaba Observatory dur the burst of the monsoon on the west coast of Indian Peninsula present many interesting featu and indicate the possibilities of a forecast be made of the approaching monsoon at least a we ahead. The seismograph, which is installed in underground constant temperature room, gi records remarkably free from microseisms dur the cold weather period.

Microseismic movements of a type which is qu characteristic of the south-west monsoon peri make their first appearance in the seismograms t the end of May with the advance of the monso in the south-east Arabian Sea, becoming more a more pronounced as the monsoon currents approa Bombay. They become less marked or disapp during a temporary break in the monsoon a reappear with the strengthening of the curren This year the first indication of disturbed weath in the south-east Arabian Sea was obtained on M 21, and microseisms of the monsoon type made th first appearance in the Colaba records on the n day; these became more marked on June 2, wh the monsoon finally appeared on the Malabar co with rough seas and heavy rain. Very well-mark microseismic movements were noticed in the rec for June 12, on which day Bombay received its fi monsoon rainfall.

S. K. BANERJI

The Observatory, Bombay,
September 12.

Potential Gradient and Atmospheric Pollution

RECENT correspondence (NATURE, April 5 a June 14) on the connexion between the potent gradient and the degree of pollution of the atmosph prompts me to put forward a suggestion to expla the alleged influence of a high-tension electric field plant growth.

It is well known to all workers with high tensi that, owing to the fact that the corona dischar takes place more readily from negatively than fr positively charged wires, the dust-particles of t surrounding air become negatively charged and a rapidly precipitated upon neutral or positive charged surfaces, the air being thus freed fr pollution. Conjoin with this fact the unquestiona deleterious influence of an excessive dust content the air upon vegetation, as illustrated, for example, the difficulties of the urban horticulturist as co pared with his rural competitor, or in the dama wreaked by a cement-works upon all vegetati in its lee, and we have at least a possible *vera cau* for the beneficial action of the high-tension ne work.

The conflicting evidence obtained by differe observers, and particularly the difference, noted l some, in the effect in dry and wet seasons, wou also find a ready explanation in the obvious fact th the greatest benefit would accrue under conditions maximum atmospheric pollution.

KERR GRANT.

The University of Adelaide,
August 4.

Optical Records and Relativity.

By Prof. C. Lloyd Morgan, F.R.S.

Probably the majority of physicists acknowledge the existence of events (and the clusters of events we call things), out there in the external world, whether we have sensory acquaintance with them or not. They believe that an object of vision is seen only when light-waves, transmitted from some cluster of physical events as their proximate source, reach the retina of the eye, and that on receipt of advenient influence which stirs sundry retinal events, there somehow arises conscious reference to an object of vision. It is not within their province to consider how this conscious reference may best be interpreted. That falls within the province of the psychologist. Just as it is for the physicist to tell the story of the manner in which light-waves take origin in some proximate source, how they reach the retina, and what is the set of physical events in the retinal record, so it is for the psychologist to tell the story of the manner in which conscious reference to the object of vision has come about.

The physicist, then, tells *his* story and leaves the psychologist to tell his story. Broadly speaking, the former is that of radiant influence from its proximate source to its proximate outcome; the latter that of perceptual reference to the object of vision.

I take it that from the physical point of view we may distinguish two sets of events. There is a set of events beyond the confines of our body, and there is a set of events within the confines of our body. In the set of external events there are specialised groups of events from which radiant influence is transmitted in ways which it is for the physicist to describe and interpret. When such radiant influence is advenient on one of the more highly developed organisms, such as we are, it forms an optical "image" on the retina of the eye. A set of events in the pattern of the image is called into being in the spread-out and curved surface of the retina. This "receptor-pattern" may be regarded as a record (within the confines of the organism) of some group of events beyond the confines of the organism. It is no less physical, as a set of interrelated events which occur in the optical record of the retina, than the set of events in the external world which is the proximate source of that record.

Beyond the record, in our present context, the physicist is not concerned to trace the further course of events within the organism. However important this may be for the elucidation of perceptual process, he leaves that to the physiologist. Hence he restricts his inquiry to the task of co-relating (*a*) the events at the proximate source of the record in the external world, with (*b*) the events in the optical record itself; but he cannot get along with this (his proper) task without conscious reference to (*a*) and to (*b*). Since this does not fall within his province, he must accept some working hypothesis as to its nature from those within whose province it does fall for consideration. There are, however, two in the field. It may be (*α*) that the spatio-temporal relations in the retinal record *reveal* those that obtain in the source of that record; that is, that in and through the record the mind directly apprehends the spatio-temporal course of events in its source; or it may be (*β*) that the nature of conscious reference in perception is such that the object of vision is fashioned on the spatio-temporal configuration *of the record*; that is, that changes in the record are referred to that which is the external source of that record.

With the aid of photography, other optical records than those in the retina may be obtained. But the photographic record, when it is seen, is an object of vision, and therefore implies a retinal record; so that we have here only an instance of vision at second-hand.

Now the first-hand optical record in the retina, or its substitute at second-hand in the photograph, has a quite definite shape, as a snapshot phase of changing spatio-temporal relations therein; and whatever may be that shape in the record, that too is the shape of the object of vision. That which gives an elliptical record is seen, under naïve perception, as elliptical. In matters terrestrial, and in matters that can be brought within the range of manipulation under touch-contact (and its ancillary measuring-rods, callipers, and so forth), there is opportunity for co-relating the spatio-temporal relations in the optical record, and in the source of that record as dealt with by manipulation. There is need for such co-relation; for the shape of a thing, say a coin, as given under reference from touch-manipulation, is often different from the shape of that thing as given in the optical record, and as referred to the object of vision.

Let us admit that the coin as a physical thing is, for our knowledge, a "construct" which we deliberately frame for scientific purposes by combining the net result of all visual and (in the case of this and other terrestrial things) all tactual records obtained in the course of manipulation. It is on this basis that the physicist acknowledges a physical thing existent in its own right; and where vision is concerned, that thing is the source of advenient influence that reaches the retina and gives an optical record. The inquirer in what may be called the field of "classical optics" (briefly characterised as "the science of light regarded as the medium of sight") is one whose special business it is to co-relate the story of physical influence with that of perceptual reference with its location of the object of vision. He has reached certain generalisations with regard to the occurrences he observes in this twofold aspect. Perhaps the most salient is this: No matter how devious the course of a light ray in accordance with the non-homogeneous medium of physical events through which it is transmitted (under refraction, reflection, and so forth), conscious reference to the object of vision is along the line of the final path of that ray by which it reaches the recording retina. This is projective reference or, as Sir Charles Sherrington calls it, "projicience" ("Integrative Action of the Nervous System," p. 324). He distinctly states that it is a *psychical* process. He traces its connexion with the evolution of "distance receptors." Initially naïvely perceptual with meaning (including visual distance) for the practical behaviour of animal life, it leads up, under further mental elaboration, to conscious reference to the object of vision. The gradually

acquired location of the object of vision is commonly interpreted in terms of this elaboration. Under optical inquiry an orderly co-relation of the "place of location" of the object of vision with the "assigned place" of the proximate source of the light rays from a physical object, is set forth in the text-books of classical optics. This is the interpretation of perceptual reference that I labelled (β) in a previous paragraph.

Under (α)—the doctrine of direct apprehension—the interpretation is quite different. It is advocated by new realists of the type of Prof. Alexander, by critical realists of the older type (represented by Prof. Dawes Hicks), and of the newer type (represented by Prof. Santayana). It underlies Prof. Whitehead's "Concept of Nature" and Mr. Bertrand Russell's "Analysis of Mind." It is certainly widely accepted on grounds not always clearly set forth; and it has authoritative expression.

What is its interpretation of conscious reference? Subject to correction, I think it comes to this in its selective form as advocated by Prof. Alexander. The entity which we call a mind is "compresent" with a vast number of certain other entities named, let us say, "sensa." Just as, in physical regard, physical influence flows in to some given physical entity from some other physical entity or entities, so too, in psychical regard, psychical influence flows in to the mind from some sensum or sensa with which it is compresent, or, at any rate, the mind is affected by them; and on receipt of such influence (or such affection) there is what we call reference on the part of that mind to the sensum or sensa. Reference, therefore, is the psychical reaction of the mind in its relation to sensa, and it discloses or reveals the intrinsic nature of the sensum with which the mind is compresent. Revelation of this order is illustrated by the direct apprehension of a certain kind of sensa in vision.

Such in its essential features is, if I mistake not, the doctrine of reference which is alternative to that of projicience or projection. The sense-organs—in our context the retinal records—are only *instrumental* to direct apprehension, for example, of a distant sensum which has in itself the quality of redness. It may be true enough that, whenever colour vision is in evidence, there always occur in the receptor-pattern of the retina, or the choroid, certain complex chemical changes. But what of that? It merely shows (if such be the facts) that the bodily instrument used by the mind in direct apprehension is of such and such a nature. It may be that it takes the human infant some seven or eight weeks clearly to focus and locate an object of vision, and perhaps another seven or eight weeks (cf. Milicent Shinn, "Biography of a Baby") to co-relate the seeing and the manipulation of that which then becomes for its apprehension one and the same object. What of that? It merely shows, if the inference from the observed facts be valid, that the physiological means subservient to the psychical end of apprehension are subject to a process of progressive development. Physiologists and biologists discuss such subsidiary matters. Direct apprehension on the part of the mind is there from the first and all the time.

We have then an α-interpretation and a β-interpretation, both distinctively concerned with a mental or psychical process; and the point of emphasis is that there are *alternative* hypotheses as to the nat and outcome of conscious reference in naïve percepti The difference between them may be illustrated the alternative interpretations of "mirror image" When a man shaves all that happens, in manipulati touch under the razor, to his chin that he cannot s happens also to the mirror image that he does s Clearly there is need for co-relating these several even The interpretation of classical optics is familiar enou On the "sensum theory"—either in its "selectiv or in its "generative" form—the co-relation of t visual sensa, apprehended as mirror-images, with t tactual sensa apprehended under manipulation of t razor (together with sundry auditory and olfacto sensa) demands a much more intricate and elabora treatment such as is discussed in Mr. Broa "Scientific Thought." There are, then, two qui different interpretations. Of these one or other clai acceptance under the searching criticism which lea from an initial assumption to acknowledgment of validity as a basis for further procedure.

Furthermore, apart from the projicience or pr jection entertained as a policy in classical optics, a discussed from an evolutionary point of view by S Charles Sherrington—apart, let us say, from t biological and psychological arguments in favour reference *from* the record *to* the object of vision—it sufficiently well known that there is, in the wider fie of thought, a philosophical hypothesis based whol on projicience—that which Prof. Wildon Carr h presented in "The Theory of Monads"; and it is al pretty clear that other idealist systems, in so far objective, proceed on the basis of the hypothesis projicience rather than of that of direct apprehensio So here again—apart from "subjectivism," which v may regard as out of court—we have to realise th there are *two* alternative interpretations of conscio reference, no doubt in somewhat variant forms.

Revert now to the concept of the optical recor photographic or retinal. All that we experience visual perception when there is an object of visi implies an optical record, whatever else it may impl in focussing the eyes and in the very complex set factors concerned in the perception of visual distanc In the case of a coin, all that we visually know cor cerning it is based on a vast number of varying optic records with intrinsic spatial relations of position points distinguishable within it. On this basis w speak of the object of vision as round, elliptical, an so forth. Speaking of the coin: Such and such (w say) it is as object of vision. But what is *it*?

There are other records of "it"—those based o tactual contact-records, with behaviour in manipula tion. These, too, are records of "the coin." We co relate these contact-records with those optical records and we incorporate both in a pretty consistent schem where each has meaning in terms of the other. In th optical record we take into consideration (a) the poin of view from which the record is obtained, (b) th physical path of the light-waves that reach that recor from some physical source, and so on. Then, con currently, we co-relate the whole set of optical record with the whole set of contact-records given in respec of the things, such as the coin, which lie within th limited reach of manipulation. Combining all the data

ided by all the records, we construct "the coin" s has, step by step, taken form in our knowledge d on these records. But what is "it"? What is e coin"? Some may say it is just this construct. ers may say: This no doubt it is for the knowledge h gradually took form in our childhood. But this struct is founded on conscious reference—if you like great number of co-related acts of referring—to a sical thing, existent "on its own" independently ll such percipient processes.

ow whether this belief or acknowledgment of the pendent existence of a specific cluster of physical nts which is the source of no less physical records ustifiable at the bar of logic or not, I submit the man of practical common sense, *and* the man cience as physicist, *do* proceed, in all their work- y hours, on the basis of this acknowledgment, as a cy if not as a creed. I feel confident that most sicists, and the general public who are interested he outcome of their inquiries, do claim that recently uired knowledge with regard to relativity demands only a radical modification of policy in dealing with physical universe, which was a "going concern" before man came on to the scene of events, but a radical modification of the orthodox scientific d now spoken of, in the past tense, as that of assical mechanics."

physical outsider meddles with relativity at his l. He may, however, ask questions, even if he be competent to make assertions. Here let it be said t, unless he be smitten with the incurable disease enile folly, he must freely and fully accept all that sical science has securely established in its splendid ance since the days of his youth. That being so, may still venture to ask questions.

1) Are we not, in the crucial issues that arise under sical relativity, dealing only with optical records, tographic or retinal, and with an acknowledged sical source of those records?

2) Must we not regard the records as physical no than their source?

3) Are we not, from the nature of the phenomena evidence, precluded from obtaining any contact- ords, under touch-manipulation, of the spatio- oral events in the distant source, though we deal ely, on this wise, with the optical record, spectro- pic or other, on the photographic plate?

4) Are we not, therefore, in physical regard, co- ating, under some relevant transformation formula, rentzian or other, the physical events optically orded, with the distant source-events thus recorded?

5) Is not the outcome: Such and such is the co- ation of *these* events with *those*?

6) May we, on the basal principle of relativity, give macy in "reality" to either set of events thus co- ated, since each is acknowledged as physically eal" in the same sense?

7) In terms of so-called "warping," are we justified saying more than that these source-events *or* those ord-events are "warped"—*i.e.* stand in need of nsformation—each relatively to the other?

8) Is it not for convenience of policy only that varp" is assigned to one or the other?

9) If, as a matter of scientific creed, primacy in eality" be given to one or the other, and we be bidden to believe that these and not those are "warped," is this on strictly physical grounds?

(10) Or is it on grounds other than physical—*meta*-physical in the Aristotelian sense—namely, in accordance with a doctrine of perceptual reference, *i.e.* of the nature of a *mental* process (however simple or however complex) and its outcome?

(11) Is there one universally accepted doctrine of perceptual reference in vision, or are there two, (*α*) direct apprehension, and (*β*) projicience (or projection)?

(12) Since, as a matter of plain history, there have been, and still are, two different hypotheses, is it for the physicist as such to pronounce judgment one way or the other?

(13) If (*α*) be accepted by this or that physicist on the basis of one of the two "metaphysical" hypotheses, should not this be stated?

(14) If the physicist, as a wise cobbler, sticks to his last, and says that the nature and origin of perceptual reference is not his business, should he not leave the matter open? If it be no concern of his, *qua* physicist, should he not hand it over to those who make it their special province of inquiry?

(15) If some of those who have given careful and prolonged consideration to this problem in all its bearings (and its bearings are many) regard the balance of evidence as, in their judgment, in favour of visual projicience, does this imply rejection of physical relativity or of any valid inference therefrom?

(16) What does all this mean for the man in the street, or the smoking-room, who is interested in such matters?

Expressed in terms which may perhaps be "understanded of the people," it means something like this:

(i.) All the established results of physical science, as such, and all valid inferences therefrom, are fully and gladly accepted.

(ii.) There are two quite different hypotheses in respect of perceptual reference. On *this* hypothesis, just as the shape of a coin as seen from any given position is that of the "image" on the retina; just as the partially immersed rod looks bent because such is its record in the retinal receptor-pattern; just as the "mirror image" of a man's chin is located differently by its owner and the barber who shaves him; just as, in these terrestrial matters of common experience, what happens in the record is the basis of all that we see, and is projiciently referred to the set of physical events which give that record; so too are all spatio-temporal changes as optically recorded (subject to Lorentzian or other transformation) projiciently referred to their distant physical source—for such is the nature of vision.

(iii.) It follows that "local spaces" and "local times" are, broadly speaking, illusions of vision, none the less interesting, none the less matters for scientific inquiry, none the less germane to the policy of physical interpretation, but still having their seat in the optical record and not in the source of events thus recorded, though projiciently referred thereto.

(iv.) It follows, too, that if transformation of events be interpreted in terms of projicience and not in terms of direct apprehension, the source-events themselves are nowise transformed, and the scientific creed of classical mechanics stands in no need of revision.

Archæology from the Air.

By O. G. S. CRAWFORD.

LONG before aeroplanes were invented it was confidently hoped that vertical photographs would some day be taken; and it was felt certain that, if so, they would greatly assist archæology. Major Elsdale was the pioneer of air-photography in the British Army. Between about 1880 and 1887 he carried out many experiments from free balloons, and also invented a method of sending up small balloons, just large

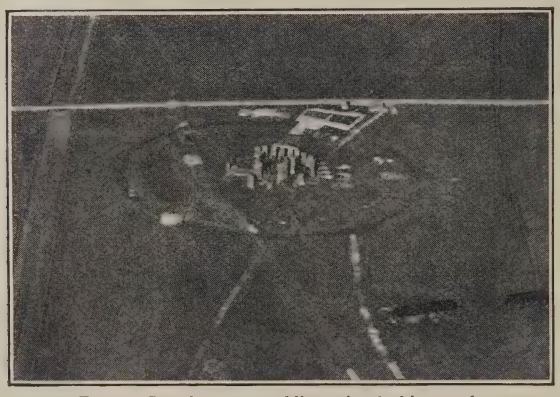

FIG. 1.—Stonehenge: an oblique view looking north.

enough to carry a camera, which exposed a certain number of plates automatically; then the balloon emptied itself of some of its gas and came down. Some of the results were quite good considering the difficulties. In 1891 Lieut. C. F. Close (now Col. Sir Charles Close) suggested to the Surveyor-General of India that the India Office should be asked to send out similar apparatus to photograph from the air the ancient ruined cities round Agra, with the view of constructing a map from the air-photos. The scheme was approved and the apparatus was sent to India; but official difficulties of the usual type supervened. The result was that Agra was cut out of the scheme; and a few photos were taken over Calcutta at an unfavourable season of the year, and the opportunity was lost. After Major Elsdale left the Balloon Establishment in 1888, little or nothing was done at home in this matter: and after 1892 the Survey of India took no more interest in balloon photography. Major Elsdale spent much of his own money on the experiments in question; but ballooning was not much in favour in the 'eighties, although some progress was made, and he received little or no official support in his balloon-photo experiments.

In 1906 Lieut. P. H. Sharpe took a vertical and an oblique photograph of Stonehenge from a war-balloon; these were published in *Archæologia* (vol. 60) by Col. Capper. During several years immediately preceding the War, Mr. Henry S. Wellcome successfully used large box-kites, with specially devised automatic control cameras for photographing his archæological sites and excavations in the Upper Nile regions of the Anglo-Egyptian Sudan.

During the War, when aeroplane photographs first became common, it might have been expected that archæological features would have been observed; but in the British sector in France none were seen, so far as I know. The photographs were often taken at a great height, over country which is archæologically barren or which was too rankly overgrown to show results. Moreover, the interpretation of air-photographs for military purposes was a new art and in itself sufficiently fascinating to oust academic interests for a time. Only on other fronts was time found for archæology in the air, and again it was an officer of the Royal Engineers who led the way. Col. Beazeley observed and photographed in Iraq in 1917, cities of which the ruins were unintelligible on the ground. On an air-photograph these ruins were seen as an orderly arrangement of streets and houses. This marked a very definite advance, for it proved that air-photography could add to knowledge, and that it would be an invaluable aid to excavation. To Col. Beazeley is due the credit for the first actual application of air-photography to archæology. In the first flush of excitement it has sometimes been forgotten that he was the pioneer in practice, and that he was the first man to take air-photographs from an aeroplane for purely archæological purpose. So far as I know, Col. Beazeley has not followed up his first results; but it is to be hoped that some one will, for Iraq is a most suitable country for "archæography."

The birth of the new study in England may be said to date from 1922 when Air Commodore Clark Hall observed certain curious marks on R.A.F. air-photos taken in Hampshire. With him must be mentioned Flight-Lieut. Haslam, who took a number of photo-

FIG. 2.—Stonehenge and environs.

graphs near Winchester showing what turned out to be Celtic fields. Air Commodore Clark Hall showed these photographs to Dr. Williams-Freeman, who told me to see them. Dr. Williams-Freeman and I had always been hoping for air-photographs of English soil; and looking at these we saw that our expectations were fulfilled, and even surpassed, by what was revealed. It was possible from these photographs to make a map of the Celtic field-system near Winchester; it was published in the *Geographical Journal* for May 1923, and reprinted in "Air Survey and Archæology

o. (Ordnance Survey Professional Paper No. 7).
.y archæological air-photographs have been taken
yhe School of Army Co-operation at Old Sarum.
ecently the Air Ministry has sanctioned the transfer
o the Ordnance Survey Office of all air-photographs
co aining archæological information, which are not

G. .—Stonehenge Avenue and tumuli (1921). The avenue is shown
ning from just above the highest point of the wood shown in the bottom
t-hand corner of the illustration and curving towards the first line of
e-clumps, the third of which from the left stands partly on the avenue.
ie tumuli appeared as faint circular markings. The course of the
enue has been slightly emphasised in preparing the illustration.

rcuired for service purposes. Thus, the connexion
bween air-photography and the Royal Engineers,
bun about 1880 by Major Elsdale and continued by
C. Beazeley, has been maintained. Needless to point
o', air-photographs are of great use, when checked
a l supplemented by field work, in revising the
a hæological information on the Ordnance Maps.

Popular interest was first aroused by the discovery of
natives showing, for the first time, the complete course
o the Stonehenge Avenue (eastern branch) (Fig. 3).
Ie history of this has been told before, and I do not
ppose to repeat it here. Full details will be found
imy monograph on "Air Survey and Archæology."
Ie photographs of the avenue were taken in the dry
yar of 1921 by the Old Sarum squadron; but their
e hæological importance was not recognised until two
yars later, in 1923. At the present moment the
pblem before us is to find a suitable method of
rroducing air-photographs, so that the pictures may
come generally accessible to archæologists for pur-
poses of study.

It is usually imagined that the camera, when fixed
i an aeroplane, records marks on the ground which
re invisible to the eye of an observer. That is not
s. The observer can see these marks more plainly
tan the camera, for he sees them in colour. The most
rmarkable discoveries which have been made are
(e to plants, which are sensitive to slight differences
(soil and moisture. For example, if a ditch has been
g on a chalk down and the down has afterwards
len ploughed flat and sown with corn, for ever after-
wards the subsoil filling (or silt) of that ditch differs from the adjacent never-disturbed soil. Nothing can ever restore chalk once dug to its former state. Archæologists have long known this, for one of the principal needs in excavation is to distinguish between disturbed and undisturbed soil. But one cannot dig up a whole field or several fields to find a ditch which after all may not exist. Here it is that a vertical view helps; for the effect of this moister silt upon a crop of corn is to promote its growth and deepen its colour. Thus from above one sees, and can photograph, a belt of darker green corn following the line of the vanished ditch. These lines are sometimes visible on the ground, from across a valley or at even closer quarters. Sometimes (as in parts of the Stonehenge Avenue) they are quite invisible. But always, when more than a single ditch is concerned, the *distant* view is necessary to convert chaos into order. The reason for this necessity can best be explained by means of a comparison. If one looks through a magnifying-glass at a half-tone illustration made through a coarse screen, it ceases to be seen as a picture and becomes a meaningless maze of blurred dots. If one holds it some distance off and looks at it with the naked eye it becomes a picture again. The observer on the ground is like the user of the magnifying-glass; the observer (or camera) in the air is like him who looks at the half-tone picture from a distance.

Now the majority of our prehistoric sites, and many later ones, were seamed with ditches and pits, dug for drainage, storage, habitation, defence or boundary purposes. Many exist to-day on the downs, undisturbed and turf covered; many more have been flattened by cultivation. All of the latter can be re-

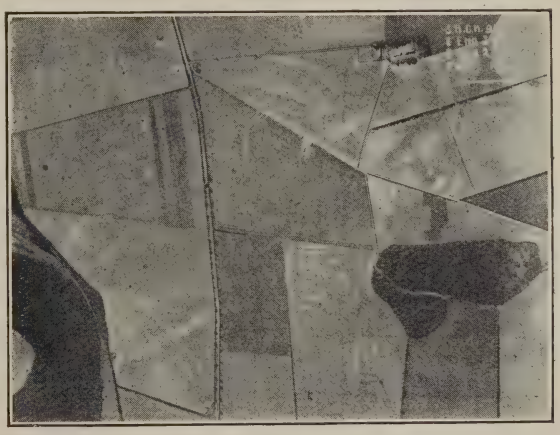

FIG. 4.—Celtic lynchets and ditches on Borough Down near Winchester.

discovered by air-photography, provided only that the arable has not been allowed to revert to grass. Even then traces of the ditches are sometimes visible, especially on poor soils and in dry summers, by a belt of darker green. Air observation, however, is most fruitful when young crops are growing; then discovery is easy and rapid, and every flight is productive. Such sites may afterwards be seen to exist by an observer on the ground; but few of them could ever have been *discovered* except from the air. Chalk is not the only soil that produces these streak-sites; they have been

observed on oolitic limestone near Bath and plateau gravel near Exbury.

A few words only are necessary to describe the other factors which enable air-photography to record ancient sites. Prehistoric cultivation-banks—what I have called lynchets of Celtic type—are revealed because they either throw slight shadows or because when ploughed they appear as belts of lighter soil, from the chalk

FIG. 5.—Battlesbury Camp, Wiltshire.

grains mixed with them. From photographs the Celtic field-system of a district can be accurately mapped. Again, rabbits work in the looser silt of filled-up ditches (as well as in the soil of the lynchets), and if there are many rabbits a white line, or row of white patches, is visible from the air. Daisies and poppies grow for choice above these ditches, and barrows and hill-top camps have thus been revealed by white and scarlet circles. "A single field which I have looked upon," we may say with Wordsworth (almost), "speaks of something that is gone; the daisy at my feet doth same tale repeat."

Lastly, the low shadows at sunrise and sunset e the outline of low banks in deep black. That is time to photograph lynchets. On a June morn before breakfast the greater part of Salisbury Plai seen to be covered with the banks of abandoned C fields; but afterwards they "fade into the comm light of day." The great ramparts of hill-top can are strong enough to throw a shadow even at m day, but they are best photographed when the sun low, for then not only do the ramparts stand out b but the banks and pits of the habitations also.

Air-photography has only recently been harnes to the chariot of archæology; but it has already fou a generous and enthusiastic patron in Mr. Alexan Keiller, and its future is assured.

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7. Articles by O. G. S. Crawford in the *Christian Science Monitor*, Decem 14 and 21, 1923.
8. German work in the Sinai Peninsula during the War; see *Wissensch Veröffentl. d. deutsch-türkischen Denkmalschutzkommandos*, Heft Sinai, Berlin; 1920.
9. W. Andrä (of Berlin); Air-photographs of Assur taken during the W by Germans; report given to the *Wiener Anthropologischen Gesellsch*
10. J. H. Breasted; publication of the Oriental Institute of the Univer of Chicago, 1920.
11. R. A. MacLean; The Aeroplane and Archæology: *American Journa Archæology*, 1923.
12. Leonhard Franz; *Wiener prähistorische Zeitschrift*, vol. x. (1923), 136, 7. (A review of No. 4, giving results of German and Ameri work quoted in Nos. 8-11.)
13. Vertical Air-photographs reproduced in the *Illustrated London News* Pompeii, general view, June 2, 1923; large scale view of cen February 16, 1924; Ur, July 28, 1923 (see also *Antiquaries' Jour* iii., Plate 24); Stonehenge Avenue, August 8, 1923.

Obituary.

MR. OTTO HEHNER.

A NOTICE of the scientific career and work of Mr. Otto Hehner, whose death is announced, will be practically the history of English Analytical Chemistry during the past fifty years.

Born at Marienberg in 1853, and educated at Wiesbaden under Fresenius, Hehner came to Britain in 1873 as assistant to Bischof at the Andersonian College, Glasgow, where he had Ramsay for a colleague. In 1874 he became assistant to Arthur Hill Hassall, who was prosecuting researches, largely microscopical, into the composition of foods, and on the means of detecting adulterations, and it was here that Hehner worked out his methods of butter analysis, far in advance of the knowledge of the day, and the foundation of modern methods; by this research he won his spurs and established his reputation for original thought. In 1877 he moved to London and established a consulting practice, which in 1881 was removed to 11 Billiter Square. Problem after problem was tackled, and Hehner's publications, chiefly in the *Analyst*, and the Journal of the Society of Chemical Industry, show t varied scope of his investigations, beeswax, glyceri oils and fats being but a few of the subjects in whi he was a pioneer worker.

Hehner was a very active member of the Society Public Analysts, and though not an original membe he was early (1883) elected secretary, and was preside in 1891. His association with the Institute of Che istry was nearly as intimate; elected a fellow in 187 he was one of the leaders of the movement that 1887 enlarged the scope of the Institute by removi the narrow restrictions of membership, and started t gradual raising of the professional status of t analytical profession by making the essential qualific tions more real. Hehner's appointment as examin to the Institute in 1895 was the real commencemei of a genuine test of knowledge in analytical chemistr and to him also the foundation of the library of t Institute is due; he filled the office of vice-president three separate occasions and was censor in 1901 to 190

Hehner held many appointments as public analyst

indeed, was more proud of this title than any title. In almost every branch of the analysis of food and drugs he has left his mark. As a witness he was superb; in the box he told a plain unvarnished tale in perfect English (although he never lost his accent), and compared conviction. Before parliamentary committees also he placed his wide knowledge, and there is no doubt but that his evidence had a distinct influence on legislation, and his expert advice was welcomed in many quarters.

During the War, Hehner devoted himself wholeheartedly to the country of his adoption; his expert knowledge of glycerin technology was placed at the service of the country without remuneration, and he served on various committees where his knowledge was invaluable. His reward was that some pettifogging local authorities removed him from his public appointments because of his German origin; how little they knew the man, who had given them such good service. Hehner was greatly hurt by this, and it affected his health; partly on this account, but chiefly to escape what he felt was an anomalous position, he went to South Africa in 1921, and though he came back, he paid another temporary visit, and died there on September 9 of a tropical fever.

Full of energy, kind-hearted and generous, especially to young men, a keen critic, and a strong fighter, but always in a fair and just manner, a firm staunch friend, a widely read philosopher, a genial companion, he had that strong personality and marvellous intuitive power that marks a leader. H. D. R.

Mr. J. Britten.

THE sudden death of James Britten, fellow of the Linnean Society and for nearly forty-five years editor of the *Journal of Botany, British and Foreign*, occurred at Brentford on October 8. He was born at Chelsea on May 3, 1846, and became attracted to the study of plants from an early age. His earliest printed paper known to the writer is in the *Journal of Botany*, in the first volume of which, issued in 1863, is a short paper on "Rare and Exotic Plants at Kew Bridge." In 1865 he removed to High Wycombe, and the four years spent in that town gave him further opportunities for studying field botany.

Short papers came from Britten's pen quickly; then in 1869 he was appointed a junior assistant in the herbarium of the Royal Botanic Gardens, Kew. Two years later he was transferred to the Department of Botany, British Museum, then housed at Bloomsbury. In 1879 the senior assistant, Henry Trimen, proceeded to Ceylon, succeeding Thwaites at the botanical garden of Peradeniya, and Britten took his place as editor of the *Journal of Botany*, which he occupied until his death last week.

Britten's independent works were a quarto on "European Ferns," in 1881–82, a reprint of William Turner's "The Names of Herbes in Greke, Latin, Englishe, Duche and Frenche, 1548," with the identification of the plants, in 1881; a list of farming words, extracted from Wm. Ellis, in 1880; and the determinations of Banks's plants issued in folio by the Trustees of the British Museum, in 1900–1905. With Robert Holland he brought out "A Dictionary of English Plant Names," 1878–84; and with Prof. Boulger "A Biographical Index of British and Irish Botanists," 1893, with three subsequent Supplements to 1908; a second edition is understood to be ready for press.

Britten, however, was better known as a keen debater and critic, in his own journal, and the number of his essays, long or short, is great. He was quick to detect the weak side of an adversary, and unsparing in attack. For many years he took an active part in the work of the Catholic Truth Society, in recognition of which he was made a knight of the order of Saint Gregory in 1897, by Pope Leo XIII., and knight commander (K.C.S.G.), *con placca*, in 1917. B. D. J.

Prof. H. Kraemer.

THE death on September 9 of Prof. H. Kraemer at Detroit, which has robbed pharmacognosy of one of its most brilliant exponents, will be much deplored by his colleagues not only in the United States but also throughout the scientific world generally. Henry Kraemer was born on July 22, 1868, and studied at the Philadelphia College of Pharmacy while still an apprentice in a pharmacy in that city. In 1889 he graduated in pharmacy there and afterwards took the degree of Bachelor of Philosophy in the School of Mines of Columbia University. He was then appointed professor of botany and pharmacognosy in the School of Pharmacy of the Northwestern University. He studied for an additional year in Marburg, chiefly under the late Prof. Arthur Meyer, and obtained the degree of Ph.D. Soon after his return to America he was called to fill the chair of botany and pharmacognosy in the Philadelphia College of Pharmacy, a position which he continued to hold until 1917, when he was transferred to a similar position in the University of Wisconsin.

From 1899 to 1917 Prof. Kraemer was the editor of the *American Journal of Pharmacy*. During this time he exhibited indefatigable industry, not only in his capacity as editor but also as research worker in the laboratory, mainly in the fields of botany and pharmacognosy. He also took an active part in the revision of the United States Pharmacopœia as chairman of the sub-committee on botany and pharmacognosy. In Great Britain he was best known by his "Scientific and Applied Pharmacognosy" and "Applied and Economic Botany," his ability receiving recognition by his appointment as honorary member of the British Pharmaceutical Conference. Prof. Kraemer exercised a widespread influence, particularly in America, by his industry and by the stimulus he imparted to others by the example he set. He was an independent thinker and gave fearless expression to his thoughts, a trait which made correspondence with him a sincere pleasure. His loss will be keenly felt.

WE regret to announce the following deaths:

Lord Abercromby of Aboukir and Tullibody, formerly president of the Society of Antiquaries of Scotland and honorary member of the Finno-Ougrian Society of Helsingfors and of the Finnish Archæological Society, on October 7, aged eighty-three.

Dr. W. B. Hemsley, F.R.S., formerly Keeper of the Herbarium, Royal Botanic Gardens, Kew, on October 7, aged eighty.

Current Topics and Events.

WE have received under the designation of "Commission F (Propaganda)" what is apparently a proposal emanating from the Twenty-third World Peace Congress to the Commission for Intellectual Co-operation of the League of Nations. We forbear to reproduce the language of this document, which has evidently been written under strong emotion. After an allusion to the fact that science often places its work at the service of war and destruction, a further allegation is made that science is frequently governed by a spirit of national hostility and narrow-mindedness, accompanied by the oppression and persecution of savants "who expressly profess another opinion." The wording of this document is not felicitous, but the meaning and purpose are tolerably clear. The Commission for Intellectual Co-operation will certainly have the goodwill of the British scientific world in its efforts to divest science from all its misuses by man, and in all efforts towards promoting international amity. We think, however, that the document before us greatly overstates the case and does much less than justice to the international sympathies that have existed and have been fostered in the scientific world. We certainly know nothing of international oppressions and persecutions following upon conflicts of opinion; we should rather have said that, before the War, the nations had nowhere reached a sense and condition of brotherhood more real than in the world of science. Not only was there a pooling of all new knowledge, but there were also numerous international organisations for co-operative scientific investigation and for deliberative and social intercourse. Few men of science in modern times have attained maturity without finding themselves linked by strong ties of friendship to a multitude of foreign fellow-workers. Certainly there are sometimes acute differences of opinion between two men of science, or it may be two schools of thought in different countries, but we have no knowledge of any oppression or persecution arising here any more than among men of the same country.

THE dictum that "for the chemist there are no waste products" is well illustrated by the exhibition which British Glues and Chemicals, Ltd., is holding in its research department at 19 Bedford Square, London, W.C.2. Although bones were used for many purposes by primitive man, and glue is said to have been first prepared from them by Papin in 1680, no industry of any importance based upon their utilisation was initiated until about a century ago. Since then the number of products made from bones has increased considerably and the quantity of bones consumed has multiplied almost beyond measure. In addition to the manufacture of glue and gelatin, the extraction and preparation from bones of calcium phosphate, in various forms and degrees of purity, is a great and growing industry. This substance is used as bone-ash in the ceramic industry, and as bone-meal, steamed bone-flour, raw bone siftings, "dissolved" bones in agriculture. Recently pure finely ground steam bone-flour, containing 65 per c tricalcium phosphate and 10 per cent. calcium bonate, has come into prominence as a food for fa stock. Other useful products obtained from bo are fat for soap and candle manufacture, ani charcoal, bone oil and pitch, and ammonium sulph A large variety of substances and commodities shown in the exhibition, and in many cases us explanatory data are added.

AT the opening meeting of the new session of Society of Chemical Industry (Manchester sectic Mr. W. J. U. Woolcock, president, gave an addr on the benefits that accrue from close co-operation the scientific and industrial branches of chemist The impetus to co-operation given by the War now passed, and we are in danger of retrogressi Lack of understanding between scientific worker a industrialist may be due to weaknesses on both sic The former is apt to forget that common sense is of more important than scientific knowledge; the lat to regard pure and applied science as unrelated sphe of activity, and to consider research in pure scie as wasted effort, particularly when times are b Members of both branches are prone to take on w for which they are not fitted by nature. It is revolutionary discoveries, especially in pure scien that we must look for help. The Association British Chemical Manufacturers has had an educat influence on the less enlightened manufacturers; working for the advancement of chemical industry helps to open up better prospects and bring ab better conditions of employment for the chemist, a by effecting successful co-operation among chemi firms, it fosters co-operation between the technical a non-technical branches of the same firm. The org isation of the chemical and other scientific exhibits the British Empire Exhibition is a splendid exam of the successful co-operation of scientific and dustrial workers.

AN archæological discovery of the highest impo ance for Indian prehistory has been made at Mohen Daro in Sind and at Harappa in the Punjab. Benea strata belonging to the Kushan culture of the seco century B.C. have been found remains of massive bri structures and a number of objects, including n types of pottery, plain and painted and both han and wheel-made, bangles of glass, paste, and she stone rings of unknown use, knives and cores of che and oblong bars of copper, assumed to be coins. number of seals, of ivory, paste, stone, and steatite, a engraved with an unknown pictographic script a figures of unicorns and bulls, in a style unknown Indian art. The absence of iron, except in the late strata, and the scarcity of metal indicate an early dat Sir John Marshall, Director-General of Archæolo in India, in describing the discovery in the *Illustrat London News* of September 20, points out the affiniti of the script to pictographs from the Mediterranea area of Mycenean age; but he is of the opinio that this culture developed in the Indus valley witho

serous modification by outside influence. Prof. Sayce, in commenting on the discovery in the issue of December 27, points out that the inscribed seals are practically identical with the Proto-Elamite "tablettes de comptabilité" found by de Morgan at Susa, and indicate intercourse between Susa and North-West India in the third millennium B.C. In the same journal on October 4, Messrs. Gadd and Sidney Smith of the British Museum described in detail, with numerous illustrations, the parallels to be found in the objects from both the sites and from Babylonia, their conclusion being that the makers of the seals were in close touch with the Sumerians and had borrowed their artistic style and the basis of their script from them somewhere about 3000–2800 B.C.

THE harbour at Esquimalt, B.C., was formerly well known as the North Pacific Naval Station, directly under the Admiralty, but is now under the Canadian Department of National Defence. The graving dock, built in 1887 by the Canadian Government, has been in constant use, but the need has been felt for something better able to cope with naval and merchant vessels of modern size, and the Federal Government decided in 1920 to construct a new dry dock. An illustrated account of this dock appears in *Engineering* for September 26, from which we learn that the dock will accommodate the largest class of ships, a depth over sill at high tide of 40 ft. being provided, while the maximum usable length will be 1150 ft. The width at the entrance at coping level is to be 135 ft. and on the sill level 107 ft. 1¾ in. To the west of the dock there is a landing wharf 800 ft. long. The main pumping plant will consist of three 42-in. centrifugal pumps direct-connected to vertical-shaft induction motors of 1000 horse-power. Eight capstans will be provided on the dock side and one at the end of the chamber. The former will have a full-load capacity of 25,000 lb. at 12 ft. per minute, and the latter a capacity of 65,000 lb. at the same speed. The construction is now well advanced and it is hoped to complete the undertaking this year. Whilst the Government Department will undertake docking and undocking, shipowners will make their own arrangements with repair firms for carrying out work on vessels while in dock.

FLOODS in India are rapidly subsiding, according to detailed information given recently in the *Times*. In northern India an improvement in the railway situation is reported, although some weeks must elapse before thorough working is restored; many important towns are entirely cut off from railway service. The roads have also been affected by the floods, and many railway bridges have been destroyed. In Delhi the floods are said to be unprecedented in living memory, and the records show that the Jumna at Delhi rose inches higher than the level of the last great floods in 1906. In the Karnal district of the Punjab 20 villages are affected, and of these 60 are said to have been destroyed. The floods of the Ganges have done considerable damage in the district of Cawnpore, where the river level is higher than has ever been recorded. At the end of September the rainfall was excessive; in 2 days the amount reported was 15 inches at Mussooree and 13 inches at Meerut. At Simla continuous rainfall was reported for 72 hours, commencing at midday on September 27.

PROF. H. B. DIXON, honorary professor of chemistry in the University of Manchester, will deliver the inaugural lecture on "The Life and Work of Ludwig Mond," in the Chemistry Theatre of the University of Manchester on Monday, October 20.

APPLICATIONS are invited for an assistantship in the Technical Records Section of the Admiralty. Candidates must have a sound knowledge of modern physics and be able to read technical French and German and have some bibliographical experience. Applications must be sent by, at latest, November 10, to the Secretary of the Admiralty, C.E. Branch, Whitehall, S.W.1.

A DIRECTOR of the Laboratory of Microbiology and Pathology, Department of Public Health, Brisbane, is shortly to be appointed. Applications for the post are invited from holders of the diploma in public health with recent special laboratory experience in microbiology. The latest date for the receipt of applications, which should be sent to the Agent-General for Queensland, 409 Strand, W.C.2, is October 27.

Two research assistants, a senior and a junior, are required by the National Federation of Iron and Steel Manufacturers, Caxton House, Tothill Street, S.W.1, for research work on blast furnace reactions at the Imperial College of Science and Technology, under the direction of Prof. Bone. Candidates must possess a good knowledge of physical chemistry, gas analysis and manipulations. Applications must reach the director of the federation by October 27 at latest.

THE new weekly journal entitled *East Africa* is devoted to the interests of east and central Africa. It makes a good start with an attractive number that contains several interesting articles, including one on cotton production in the Sudan and another on the pastoral and agricultural possibilities of the highlands of Kenya, Uganda, and Tanganyika. The journal promises to be of value to all interested in the development of the lands of East Africa.

THE Air Ministry has announced that the two-seater dual control light aeroplane competition, which concluded at Lympne on October 4, has resulted in the production of new aeroplanes and engines of great interest and value from a practical and technical point of view. The aeroplanes, which were all widely divergent in design, proved themselves to be thoroughly efficient and satisfactory, and the power plant showed itself capable of carrying out all the tests prescribed, including the ten hours' reliability test. On the other hand, it was found necessary to run the engines at such a high speed in order to secure the maximum competition performance, that trustworthiness suffered. The Air Ministry is therefore reviewing the whole of the engine position with the view of obtaining the necessary technical data,

free from the adverse conditions inherent in a competition of this nature.

THE Paris correspondent of the *Times* states that M. Callizo, the French airman, has created a world "record" for altitude by reaching the height of 11,841 metres (38,843 ft.) in a flight made on October 10. M. Callizo's barogram has been verified at the École des Arts et Métiers. The previous record was held by M. Sadi-Lecointe, who reached a height of 35,239 ft. at Villesauvage, France, on September 5, 1923.

THE "Cobb" lectures, which were delivered before the Royal Society of Arts in March and April of the present year by Dr. T. Slater Price on "Certain Fundamental Problems in Photography," are published in full in the Society's Journals for September 5, 12, and 19. The three lectures form a concise but comprehensive statement of the present state of knowledge concerning the gelatino-bromide photographic plate. Dr. Slater Price deals first with gelatin and especially its physical properties and matters related thereto. He passes on to the colour of silver deposits produced in gelatin films by photographic processes, the nature of the developable as well as of the printed out image, the theories of the nature of the action of light and the "centres" of sensitiveness in the grains, and other matters. Those interested in these things will find it a great help to have the various results brought together as they are here, with the valuable critical and comparative rema of the lecturer.

THE latest catalogue of Mr. F. Edwards, 83 H Street, Marylebone, W.1 (No. 462, British Emp Series, No. 5), deals with books, engravings, drawin and maps relating to Canada, West Indies, Brit Guiana, and Falkland Islands.

WE have received from Mr. W. H. Robins Nelson Street, Newcastle-upon-Tyne, a copy of catalogue No. 11, 1924, of second-hand books. T catalogue, which is of a miscellaneous character, c tains the titles of a good many works likely to inter readers of NATURE, *e.g.* a section is devoted to bo illustrated by Thomas and John Bewick, and oth to botany, natural history, folklore and archæolo The prices asked appear to be reasonable.

A NEW book by Prof. Ellsworth Huntington announced by Charles Scribner's Sons. It is entit "The Character of Races: their Formation a Modification by Environment," and is a study the ways in which racial character is moulded a modified by environment. Another book in the sa publishers' announcements is "Racial Realities Europe," by L. Stoddard. In this volume the follo ing subjects are dealt with: racial realities, kindr Britain, the Nordic North, composite France, t Mediterranean South, Alpinised Germany, disrupt Central Europe, the Alpine East, the Balkan flu Turkey, Arab lands, and the new realism of science

Our Astronomical Column.

COMETS.—Encke's Comet has brightened remarkably, and is now on the verge of naked-eye visibility. A photograph by Mr. G. Merton shows a short tail. It is 138 years, or 42 revolutions, since the comet was first seen, but the loss in brightness during that period is not noticeable, in spite of the small perihelion distance. Some thirteen years ago the late Mr. W. T. Lynn suspected that the comet was fading, but the loss of light, if present, was only temporary.

Dr. W. Baade succeeded in photographing Reid's Comet, 1924*a*, on September 27 with the Bergedorf reflector. It was of magnitude 16 as compared with the calculated magnitude 10, indicating great physical loss of light. The position was within 4′ of the Copenhagen orbit.

MARS.—*L'Astronomie* for August contains several drawings of the planet Mars, made during June and July. The southern hemisphere was then in its spring, the summer solstice being passed on September 30. The southern polar cap was large and showed much interesting detail. It was crossed by two large dark rifts, and the region Argyre on its edge was brighter than the rest of the cap.

M. Antoniadi, who has been observing with the 30-in. Meudon refractor, gives a series of measures of the size of the polar cap in the *Comptes rendus* of the Paris Academy of Sciences for September 22. Several years ago he contributed a paper to the Royal Astronomical Society indicating that the size and rate of melting of the cap vary with the solar cycle. The size is greater and the melting slower in times of sunspot minimum and diminished radiation. It is noted that the present results are in full acco with this, and that the late winter and spring of t Martian southern hemisphere appear to have be colder than the average.

THE SPIRAL NEBULÆ.—Dr. K. Lundmark co tributes a paper to the *Observatory* for Septemb dealing with the radial velocities and proper motio of the spiral nebulæ. He includes some nebulæ the class described by Reynolds as globular, sin they share the high radial velocity. He finds t following values for the solar apex and motion:

(1) From the radial velocities of 43 spirals—

R.A. of apex . .	$20^h{\cdot}3 \pm 3^h$
Decl. . . .	$+75° \pm 30°$
Velocity . . .	651 ± 135 km./sec.

The large K term of $+793 \pm 88$ km./sec. is indicated

(2) From the very small and uncertain prop motions of seven spirals—

R.A. of apex . .	$1^h{\cdot}7 \pm 5^h$
Decl. . . .	$+63° \pm 46°$
q	$0{\cdot}0074'' \pm 0{\cdot}0055''$.

Deduced mean distance of spirals 61,000 light years

No allowance has been made for proper motion comparison stars, which were of about magnitude 1

The two positions of the apex do not differ mo widely than we should expect from the large probab errors. Both R.A. and Decl. are considerably larg than the values, 18^h and $+30°$, given by the near stars, suggesting that the whole group of stars rou the sun is drifting relatively to the group of nebulæ

Research Items.

REHISTORIC IVORY FIGURINE FROM EGYPT.—ng the more important objects discovered by the ish School of Archæology at Qau in Egypt during theexcavations of last season was a female figure rudly carved in ivory. It differs from any of the prehisric ivories hitherto known. On the same site we found ripple pottery and a number of objects—a gbular vase with four small handles, a long narrow ate, a flint dagger, and a small oval vase with cylidrical neck, all of types not previously known. It ould appear that these finds represent a culture apt from the usual prehistoric Egyptian, though on uth the same level and using the same materials but in different way. The ivory figure is not of the steopygous type. The arrow heads and other flint wor point to a connexion with the makers of the Faum desert flints, which are of Solutrean style. Sir Fliders Petrie in describing these finds in *Ancient Egbt*, 1924, Pt. ii., suggests that the culture may have oriinated in Central Asia, whence the Solutrean wokers are supposed to have come. This civilisation, forwhich the name Badarian is suggested provisionall from Badari, the district around Qau, would thus be the earliest of any known in Egypt, though not necssarily contemporary with the European Solutrn period.

URRENCY OF THE GUPTA DYNASTY IN EASTERN INIA.—In the course of some notes on the Gupta an later Gupta coinage in the Journal of the Asiatic Sciety of Bengal, N.S., xix., Pt. 6, Mr. N. H. Bittasali discusses the origin of the so-called "nitation Gupta coins." These coins are of base gol and approximate to a standard of 95 grains, coiderably less than the Gupta standard. They wre in circulation in Eastern India only. Although thy cannot be attributed to the Gupta imperial dyasty, it is evident that they were issued by a faily which had a veneration for Gupta traditions. Its also evident that the king who was responsible fotheir issue claimed paramount power in virtue of th performance of the horse sacrifice. This would pot to the first king of the Gupta dynasty of Mgadha, Aditya Sana Deva, who rose to power after th death of the last sovereign of the imperial line, wh which he was connected, and is known to have celebrated the horse sacrifice. The fall of the Mgadha dynasty was followed by a period of anrchy in which all knowledge of arts and crafts was lo:, so that when the Mohammedans first entered Bgal they found that the only currency in use cosisted of cowrie shells, no minted money having bn struck for four centuries.

PRAKRIT AND SANSKRIT LINGUISTICS.—Sir George Gerson has won for himself a world-wide reputation b a long series of masterly works upon the languages oHindustan, culminating in the magnificent "Lingstic Survey of India" published by him for Gvernment, and now happily almost completed. Hs latest contribution to these studies is "The Pkrit Dhātv-ādēśas according to the Western and th Eastern Schools of Prakrit Grammarians," published in vol. viii., No. 2, of the Memoirs of the Atic Society of Bengal. As is generally known, the mdern Aryan languages of India are all derived from t ancient dialects represented in literature by the Vdic and Sanskrit. The intermediate links were the Pkrits or ancient forms of popular speech, which in tir turn were cultivated for literary purposes and sdied by many grammarians, whose surviving vrks, so far as they are known, fall into two classes, an Eastern school, deriving from Vararuci and his successors, and a Western school, based upon Hēmacandra. The present work deals with the verbal roots which are specifically recognised by the grammarians as used in Prakrit and as differing from the corresponding Sanskrit roots. It consists of two indexes: the first of these contains the Prakrit roots arranged alphabetically, in the order of their Sanskrit forms, in parallel columns showing the respective paradigms quoted by five leading native grammarians, while the second presents the roots arranged in their own alphabetical order with parallel columns showing the various meanings assigned to them by the same grammarians. It is rounded off by an introduction and an appendix containing the text of a chapter on the same subject from the Prākṛita-kalpataru, a Sanskrit grammar by Rāma Śarman, and altogether will be of the greatest utility to students of the ancient literary Prakrits and the modern vernaculars of India.

CONTROL OF PESTS IN GLASS-HOUSES.—The Annual Report for 1923 of the Experimental and Research Station at Cheshunt gives a record of steady progress and widening scope of activity. The variety and manurial trials with tomatoes have been revised to bring them more into line with present-day requirements, and valuable results are anticipated. A definite relation has been determined between manurial treatment and blotchy ripening of fruit, the proportion of blotchy fruit being heavy when the soil is deficient in both nitrogen and potash, and reduced when these substances are added to such soil. Experiments on the destruction of red spider by fumigation indicate that the action of gases and volatile liquids is ineffective owing to their rapid escape from the atmosphere in glass-houses and owing to the difficulty of keeping up a comparatively high concentration of the vapour sufficiently long to kill the spider. As recorded by Messrs. E. R. Speyer and O. Owen in NATURE of June 7, p. 820, naphthalene, when heated, seems to be the type of fumigant best suited to the purpose, provided that, within broad limits, the amount of its vapour in the atmosphere can be controlled so that no injury is caused to the plant. Other tests show wood-lice can be controlled by the introduction of small quantities of phenol into the soil, but unless commercial phenol can be utilised, the method is too expensive for ordinary use. In view of the suggested fertilising value of increased quantities of carbon-dioxide in the air of glass-houses, continued experiments have been made to overcome the technical difficulties involved in the control of the concentration of the gas, and increased yields of tomatoes have been obtained in certain cases, encouraging further research on the subject.

SURFACE TENSION OF SPRAY LIQUIDS.—In the control of insects by poisonous sprays, the power of the liquid used to wet and spread over the surface to which it is applied is as important a factor as its toxicity to the organism against which it is directed. Woodman (*Journ. of Pomology and Horticultural Science*, iv., No. 1) has now shown by carefully devised physical experiments that the surface tension of a spray liquid may be reduced to a certain critical value by the addition of small quantities of soap, under which conditions the surfaces of leaves are easily wetted and the maximum amount of spray liquid retained by them. Further reduction of surface tension increases the "spreading power" of the spray though not its "wetting power." Increases of viscosity by the

addition of gelatine at about 0·3 per cent. concentration causes the retention of much more of the spray fluid on account of the adsorption of gelatine by the leaves. Forcible spraying, when the drops pass rapidly through the foliage, also augments retention. By measuring the areas of spread of lenses of liquids on wax surfaces, it has been determined that the reduction of surface tension of the spray fluid below 32 dynes/cm. greatly increases the area of spread. This indicates the economic advantage of soap as a "spreader," owing to the very low surface tension of dilute soap solutions. The greatest spread is obtained with small drops applied with considerable force, which supports the advocated practice of mist-like spraying, though it is pointed out that reduction in the size of drops would lead to decreased "force" in passing the leaves and so to a lessened retention of the spray liquid.

WATER ABSORPTION BY COCO-PALMS.—The *Philippine Journal of Science* for July 1924 contains a paper by Messrs. R. B. Espino and J. B. Juliano dealing with the rate at which roots of *Cocos nucifera* (*in situ*) absorb three- or four-salt culture solutions. The solutions absorbed most rapidly are characterised by a rather high proportion of magnesium sulphate. In this respect the results resemble those previously obtained for rice, except that the latter apparently requires less concentrated culture media. Maximum absorption in the coco-palm takes place between one and two o'clock in the afternoon, and it is shown that variations in the rate of absorption correspond quite closely to variations in the rate of transpiration. The apparent width of the leaf pinnæ is inversely proportional to the rate of absorption. The fact that water absorption depends upon the evaporating power of the air leads the authors to suggest that successful cultivation of this palm is possible even in climates usually regarded as too dry, if soil moisture is supplied in sufficient quantity.

THE GENETICS OF TOBACCO.—While parthenogenesis has been known to occur in two varieties of *Nicotiana Tabacum* grown in England, various tests have shown that this process is almost unknown in North America. The question has been re-examined at Pusa by Messrs. G. L. C. Howard and Kashi Ram (Mem. Dep. Agric. in India, Bot. Ser. 13, No. 1), who were unable to obtain evidence of parthenogenesis in either of the varieties tested. Parthenocarpy, however, occurred in *N. Tabacum*, var. *Cuba*, this always being associated with white flowers and also with especially vigorous growth of the parent plant. The inheritance of characters in Indian varieties of *N. rustica* has also been studied by G. L. C. Howard, and the results are described in the same number of these memoirs. Neither parthenogenesis nor parthenocarpy were observed. The characters of the F_1 plants were intermediate between those of the parents, except that the average height was always greater than that of the taller parent. The difference between short and tall types appears to be due to a single factor which causes elongation of the internodes both of the stem and of the inflorescence. A frilled leaf margin is dominant to a smooth edge and is apparently associated with the presence of a single factor.

RAINFALL MAP OF SWEDEN.—Owing to the widespread distribution of rainfall stations in Sweden which has grown since the start of the Hydrographic Service in 1907, it has been found possible to produce a rainfall map of the country with much greater accuracy than of old. Nederbördskartor över Sverige by Axel Wallen appears as Band 2, No. 3 of *Meddelanden från Statens Meteorologisk-hydrografiska Anstalt*. It contains a map of the annu rainfall based on the figures from 1881 to 1920 a twelve maps of monthly rainfall. In the nort where stations are few, the records probably do n express the full value of the fall and they have be adjusted by data derived from the flow of river In the north-east, such corrections should probabl also be made, but the figures do not appear to b available. The paper contains a summary of th data employed and a discussion of the cartograph methods employed. The Swedish rainfall figur for 1923 are published by the same department Aarsbok. 5. The volume includes rainfall maps f each month of the year 1923.

EXPERIMENTS ON A MERCURY ARC RECTIFIER.—In the *Zeitschrift für Physik* for August 8, Messr W. Schottky and J. von Issendorff describe exper ments designed to elucidate the peculiar effect pr duced when different voltages are applied to the wa of a mercury arc rectifier. The current curv obtained with a probe electrode was quite similar t that with the rectifier; when the electrode wa 12·2 volts above the cathode voltage, the current, flowing from the discharge into the electrode wa zero; but it very rapidly increased, as the voltag diminished, towards a saturation value. The greate part of the rise of current took place between +12· and zero volts, after which down to −100 volts rose very slowly indeed. To determine the nature this current, the authors measured the heating effe produced by it in the probe electrode, by means an auxiliary heating coil, insulated in such a wa that the whole of the heat produced by it went int the electrode. In this way the watts required to giv the temperature rises produced by the current I a different voltages were determined, and it was show that, with constant current through the electrod the connexion between the heat produced and th voltage was a linear one. The relation was suc that, within the limits of accuracy of the measure ments (about 20 per cent.), it can be stated that th subsidiary current is due entirely to the flow positive ions into the electrode. There is therefor no secondary production of cathode rays in the regio examined. There is a distinct dark space round th probe, which only vanishes when it is made the anod The suggestion previously made, that measurement of potential in the mercury arc with a probe ar several volts too low, is confirmed.

THE EMISSION OF ELECTRONS CAUSED BY α-RAYS —Dr. A. Becker has carried out a very comprehensiv investigation on this subject, in which the phenomen were studied in high vacua. The α-rays were sen through foils of different thicknesses of aluminium silver, and gold, and the movements of the electron were controlled by fields of different signs and differen intensities, produced between an electrode consistin of the preparation holder and foil and a surroundin electrode, or a parallel plate (*Annalen der Physik* September). About ten electrons were produced pe α-particle, when this had the velocity $1{\cdot}5 \times 10^9$ cm per sec., and about twenty with half this velocity using any of the three metals. It was shown that th emission requires no essential outside acceleration, s that the electrical method employed in determinin the velocities of the electrons, or δ-rays, is good i principle. Using a central field (an outer spherica electrode with the preparation holder at the centre the curve of velocity distribution is very similar t that of the electrons from an incandescent solid, bu varies from this at high velocities, which are mor

...cent in the first curve than in the second. Within ...imits of experimental accuracy, the first curve ...s with the Maxwell law of velocity distribution. ...e results were confirmed by experiments using ...geneous fields between two parallel condenser ...s. It is probable that the distribution of velocity ...lependent of the direction of emission, and that ...distribution in different directions follows the ...e law. The distribution of velocity, and its ...lute value, are independent of the nature of the ...l employed and of the velocity of the α-rays. ..." most probable " velocity corresponds to a ...tial drop of about two volts; higher velocities ... those corresponding to about twenty volts cannot ...certainty be shown to exist. The results make ...certain whether the two kinds of electron emission ...tioned can be regarded as due to the same funda...tal mechanism.

SINTERED GLASS FILTERS.—The *Chemiker Zeitung* ...4, vol. 48, p. 693) contains an account of the tests ...ed out by Moser and Maxymowicz at the Tech...ne Hochschule, Vienna, of the new glass-filters ...e by the well-known Jena firm of Schott und Gen. ...se filters are an improvement upon the asbestos ...s of the Gooch crucible, since the glass filtering ...r is fused into the glass crucible, the lower rim of ...ch projects beyond it for protection. Various ...les are made according to the fineness of the ...ipitates to be collected. Successful quantitative ...s were carried out with silver chloride, lead sul...te, lead chromate, mercuric sulphide, cuprous ...cyanate, nickeldimethyl glyoxime, barium sul...te, calcium oxalate, etc. The calcium oxalate ...be weighed as $(COO\,Ca)_2 . H_2O$ and attempts are ...g made to estimate various metallic ammonium ...sphates as such. The filters were found to resist ...action of dilute and concentrated acids, including ...a regia, but are readily attacked by alkalis. ...eous ammonia can, however, be used. The main ...dvantage lies in the fact that variations of as much ...0·4 mgm. were found in the weighings unless the ...cibles were allowed to stand for several hours in ...desiccator.

CHEMICAL CONSTANTS.—In the April-July volume of ... *Compte rendu des Séances de la Société de Physique,* ...Geneva, the question of the calculation of the ...ropy of a gas from the point of view of the quantum ...ory is discussed by A. Schidlof. It is pointed out ...t the problem involves the quantification of the ...rgy of translation of the gas molecules, and the ...iculties arising out of this are mentioned. In the ...e of a gas consisting of N molecules in a volume V, ... volume V/N may be taken as that in which the ...antified motion takes place (Sackur), or, alterna...ely, the cube of the mean free path (Schrödinger). ...ere is only one case free from ambiguity, namely, ...en the volume V contains only one molecule which ...n assume all the states of motion compatible with ... conditions imposed. With this case, an expression ... the entropy is found containing an additive con...nt, and it is claimed that neither Nernst's theorem ...r the quantum theory allows of this constant being ...glected. In the calculation of the chemical con...nt of a monatomic gas, the number N does not ...pear in the result, and the author shows that it ...also unnecessary to introduce it into the deduction. ...e formula is that of Sackur, and differs from that ...nd by Tetrode and by Planck.

THE COMPOSITION OF CHROMIC ACID.—The hydra...n product present in an aqueous solution of chromium trioxide has usually been supposed to be dichromic acid, $H_2Cr_2O_7$, on the basis of the colour of the solution and conductivity measurements combined with cryoscopy. In the August number of the Journal of the Chemical Society, Mr. H. T. S. Britton describes some measurements with the hydrogen and oxygen electrodes in solutions of chromic acid which lead to the result that the acid is H_2CrO_4, dissociating in two stages: $H_2CrO_4 \rightleftharpoons H^{\cdot} + HCrO'_4 \rightleftharpoons 2H^{\cdot} + CrO''_4$. The first stage is almost complete in dilute solutions; the second dissociation constant is very small, $4{\cdot}4 \times 10^{-7}$ at 18°. The use of the oxygen electrode as an indicator of both hydrogen ion concentrations and as end-points in titrations was made possible by comparison with the hydrogen electrode, and the method used appears to offer possibilities of application in other fields.

ATOMIC WEIGHT OF ALUMINIUM.—The June issue of the Journal of the American Chemical Society contains a description of the analysis of aluminium chloride by H. Krepelka, of the University of Prague. In a previous determination, with Prof. T. W. Richards, the value 26·963 was found as a mean of four analyses of aluminium bromide, the value given in the International Tables being 27·0. In the present research, pure aluminium chloride was synthesised from very pure chlorine and the purest obtainable aluminium. Eleven different fractions of the chloride, digested and repeatedly sublimed in nitrogen and in a vacuum, were analysed. The ratio $AlCl_3 : 3Ag$ was determined, with three different samples of standard silver. The mean of the eleven determinations is $Al = 26{\cdot}972 \pm 0{\cdot}001$, with $Ag = 107{\cdot}88$ and $Cl = 35{\cdot}458$. The most probable figure is considered to be the mean value of 26·963 and 26·972, namely, 26·97. It is remarked that, according to Aston, aluminium is a pure element, of mass 27, its nucleus being composed according to the scheme $4n + 3$. The new result confirms the previously accepted value of slightly less than the sum of the nuclear masses of helium (4·00) and hydrogen (1·008), and although the three hydrogen nuclei are satellites, the new value suggests a slight loss of mass due to the disturbing effect of electromagnetic forces within the nuclear system.

PSEUDO-EPIBERBERINE.—In the August number of the Journal of the Chemical Society, Buck and Perkin describe experiments which involve at one step the condensation of 1-homopiperonyl-6 : 7-dimethyltetrahydroisoquinoline with methylal, under conditions the same as those previously used by Pictet and Gams. Crystalline products, however, could not be isolated. When the methyl alcoholic solution was treated with formaldehyde, the formyl derivative separates as a gum, and on warming with hydrochloric acid, this is at once converted into the sparingly soluble salt of what was anticipated would prove to be tetrahydroepiberberine. It was proved conclusively that this was not the case, and that the mode of condensation assumed by Pictet was incorrect. The isomeric alkaloid produced is called tetrahydro-pseudoepiberberine. For example, when treated with sodium hydroxide, the substance decomposes into oxypseudoepiberberine and dihydro-pseudoepiberberine, a reaction exactly analogous to one previously investigated in which epiberberinium chloride is converted into oxy-epiberberine and dihydro-epiberberine. In the same journal, Haworth, Perkin, and Rankin show that a similar state of affairs exists with respect to berberine, and that the tetrahydroberberine described by Pictet and Gams is probably not that substance, but an isomeride.

International Mathematical Congress.

THE International Mathematical Congress at Toronto opened on Monday, August 11, with a speech of welcome to the assembled members by Dr. H. S. Beland, Minister of Soldiers' Civil Re-establishment and Health. Dr. Beland, who spoke in English and French, conveyed to the mathematicians greetings from the Premier of the Dominion of Canada, who unfortunately found himself unable to be present. Sir Robert Falconer, president of the University of Toronto, also gave a brief speech of welcome. Prof. J. C. Fields, chairman of the organising committee, and Prof. C. de la Vallée Poussin, president of the International Mathematical Union, addressed the meeting. Prof. G. Koenigs, general secretary of the International Mathematical Union, assisted by Prof. W. H. Young, read a list of delegates to the Congress. This list was only provisional, since much of the information with regard to delegations was not available at that time. The large number of delegates officially appointed to represent governments, learned societies, universities, and other institutions was a distinctive feature of this Congress in comparison with those previously held.

At the close of the opening session a general session was held for the election of officers. Prof. J. C. Fields was elected president of the Congress, and the following vice-presidents were elected: Prof. B. Bydžovský, Prof. F. M. Da Costa Lobo, Prof. L. E. Dickson, Senator F. Faure, Prof. H. Fehr, Prof. L. E. Phragmén, Prof. S. Pincherle, Prof. E. Schou, Prof. C. Servais, Prof. C. Störmer, Dr. W. Van der Woude, Prof. W. H. Young, and Prof. S. Zaremba. Profs. J. L. Synge and L. V. King were elected general secretaries.

The various sections held their opening meetings at 2.30 P.M. The following acted as introducers for the sections: Sect. I., Prof. J. C. Fields; Sect. II., Prof. J. L. Synge; Sect. III. (a), Prof. J. C. McLennan; Sect. III. (b), Prof. C. A. Chant; Sect. IV. (a), Mr. T. H. Hogg; Sect. IV. (b), Prof. T. R. Rosebrugh; Sect. V., Mr. Robert Henderson; Sect. VI., Dean A. T. De Lury. After the reading of papers before the sections the members of the Congress attended a garden party given by Prof. and Mrs. J. C. McLennan at the York Club. In the evening Prof. Carl Störmer of Christiania delivered a lecture on "Modern Norwegian Researches on the Aurora Borealis."

On Tuesday, August 12, the sections met at 9 A.M. In the afternoon Prof. F. Severi of Rome lectured on "Géométrie algébrique." After the lecture the members of the Congress were the guests of the Lieutenant-Governor and Mrs. Cockshutt at a garden party at Government House. In the evening there was a conversazione at Hart House, at which the members had an opportunity of inspecting this great centre of student social life in Toronto.

On Wednesday morning, after short sessions of the sections, M. E. Cartan lectured on "La théorie des groupes et les recherches récentes de géométrie différentielle." In the afternoon, at a special convocation of the University of Toronto, honorary degrees of Doctor of Science were conferred on the following members of the British Association and the International Mathematical Congress: Sir David Bruce, Prof. de la Vallée Poussin, Sir Charles Parsons, Profs. Koenigs, Stekloff, Severi, Sir Ernest Rutherford, and Sir John Russell. After the Convocation, the members were entertained by the University at a garden party. In the evening Prof. W. H. Young lectured on "Some Characteristic Features of Twentieth Century Pure Mathematical Research."

On Thursday, August 14, the members of the Congress crossed to Niagara and availed themselves of the kind invitation of the Hydro-Electric Power Commission of Ontario to inspect the generating plant at Queenston, being afterwards entertained at lunch as the guests of the Power Commission at the Clifton Inn, Niagara Falls. After viewing the Falls and the Rapids, the members returned by boat to Toronto.

On Friday, August 15, a general assembly of the International Mathematical Union was held for the election of officers. Prof. S. Pincherle, of Bologna, was elected president, and Prof. G. Koenigs, of Paris, general secretary. After this meeting, sessions of the sections were held, and in the afternoon lectures were delivered by Prof. L. E. Dickson, of Chicago, on "Outline of the Theory to Date of the Arithmetic of Algebras," and by Prof. S. Pincherle on "Opérations fonctionnelles." The members then attended a garden party at the Grange, given by the council of the Art Gallery, and in the evening the Hunt Club was kindly placed at their disposal.

On Saturday, August 16, the sections met at 9 A.M. At 2 P.M. a wreath was laid at the base of the Soldiers' Memorial Tower. At 2.30 P.M. Prof. J. Le Roux delivered a lecture, "Sur l'intégration des équations aux dérivées partielles par des intégrales définies." At 5 P.M. the closing session of the Congress was held. Prof. J. C. Fields, president of the Congress, expressed the thanks of the Congress to all those who by their generous hospitality or services had contributed to its success. Prof. S. Pincherle and Major P. A. MacMahon also spoke, and Prof. J. L. Synge, general secretary, reported on the membership of the Congress. The following resolutions were adopted by the Congress at the closing meeting: proposed by Prof. J. L. Synge (Toronto), seconded by Dr. B. Bydžovský (Prague), "That this International Mathematical Congress assembled at Toronto hears with pleasure that the Royal Irish Academy contemplates the publication of a collected edition of the works of Sir William Rowan Hamilton"; proposed by Prof. C. V. Raman (Calcutta), seconded by Prof. G. A. Bliss (Chicago), "That the best thanks of the members of the International Mathematical Congress are due to Dr. J. C. Fields and to all those mentioned by him as having contributed to the success of the Congress, and that this vote of thanks be communicated to them."

The members of the Congress and friends assembled for the last time at a dinner in Hart House on Saturday evening. Those members of the Congress who went on the western excursion with the British Association left Toronto on the night of Sunday, August 17.

Although the attendance suffered considerably from the fact that the Congress took place while many summer sessions in the universities of the United States were in progress, the registered membership was 386. This number does not include accompanying relatives. The membership was distributed by countries as follows: Argentine, 2; Belgium, 7; Canada, 67; Cuba, 1; Czechoslovakia, 3; Denmark, 3; France, 25; Georgia, 1; Great Britain, 39; Holland, 4; India, 2; Ireland, 3; Italy, 11; Mexico, 1; Norway, 5; Poland, 3; Portugal, 2; Rumania, 1; Russia, 5; Spain, 3; Sweden, 3; Switzerland, 4; Ukraine, 1; U.S.A., 189; Yugoslavia, 1.

The number of papers presented was very great—235 in all, exclusive of the lectures already mentioned. Of these papers, some, in the absence of the authors, could only be presented by title. On account of the desirability of affording the members an opportunity of seeing Niagara Falls, and also in view of the many entertainments so generously offered, the time available for the reading of so many papers was none too

g It was found necessary, on some of the days, h/e all the eight groups representing sections and ctions in operation simultaneously, and thus ers had to make an invidious choice between arious groups at which papers of rival interest ere being presented. In the circumstances, it was ult to suggest a remedy for this state of affairs lle than the expedient of cutting down the time nce for individual papers so far as to detract sly from their interest. The general maximum allowance for a paper was twenty minutes, but case of certain communications, which might be led as lectures to individual sections, this allow- was increased up to one hour. Such sectional es were: Prof. J. Pierpont: Non-Euclidean etry from a Non-Projective Standpoint on II.); Prof. V. Bjerknes: Solved and Un- Problems in Dynamical Meteorology (Section b)); Prof. J. B. Pomey: Sur les nouveaux eils multiplex de télégraphie (Section IV. Prof. G. Puppini: Principe de réciprocité dans sciences appliquées (Section IV. (a)); Sir es Parsons: Physics and Engineering (Section a)); Prof. J. G. Gray: Gyroscopic Stabilisers on IV.); General Charbonnier: Sur le balis- extérieur (Section IV. (b)); Prof. A. L. ey: Use of Mathematics in Economic, Social, ublic Statistics (Section V.).

e numbers of papers presented to the various ns were: Section I. (Algebra, Theory of Num- Analysis), 56 papers; Section II. (Geometry), apers; Section III. (a) (Mechanics, Mathe- al Physics), and III. (b) (Astronomy, Geo- cs), together, 55 papers; Section IV. (a) (Elec- l, Mechanical, Civil and Mining Engineering), IV. (b) (Aeronautics, Naval Architecture, Ballistics, Radiotelegraphy), together 47 papers; Section V. (Statistics, Actuarial Science, Economics), 24 papers; Section VI. (History, Philosophy, Didactics), 13 papers.

The classification of papers into the various sections, a matter always arbitrary to a certain degree, was left almost entirely to the judgment of the authors themselves, who would naturally seek the most sympathetic audience. It will be seen that, as usual, the Section on Analysis had more communications than any other, being closely followed by the combined Physics and Astronomy Section. Section IV., embracing the various branches of engineering science, was a new development for this Congress. Although the number of papers in Section V. was not large, yet the meetings of this section were very successful, and recognition is due to the activity of Mr. Robert Henderson, of the Equitable Life Assurance Company of New York, in helping to stimulate American interest in this section.

In order to increase the interest of the meetings and to facilitate discussion, the organising committee had abstracts of the papers printed and ready for distribution among the members on registration. These abstracts were supplied by the authors. This was a very successful measure so far as it went, but many authors failed to send in abstracts although asked to do so in the preliminary circular. If funds permitted at future congresses, it would be a good plan to urge upon authors more strongly the desirability of furnishing such abstracts for printing and distribution during the meeting.

The place of meeting of the Congress which is due to be held in 1928 is not yet fixed. It is to be hoped that the political restrictions on the membership of the congresses will be removed before that date.

Miners' Flame Safety Lamp Gauzes.[1]

ALTHOUGH a period of 109 years has elapsed since Sir Humphry Davy gave to the world e first wire-gauze safety lamp, the mesh of the ues in use to-day is identical with that adopted e original Davy lamp. In the near future, wever, it is highly probable, as a result of the uable researches conducted under the auspices of eliners' Lamp Committee, that safety lamp gauzes l have 400 apertures per square inch (20 mesh) ad of 784 apertures per square inch (28 mesh).

ese researches showed that two 20-mesh gauzes S.W.G. wire could be regarded as safe, and that type of gauze, by affording increased ventilation lamp fitted with it, materially increased the le power that could be obtained from it. Acting he advice of this Committee, the Secretary for ns arranged with the co-operation of leading manu- rers of flame safety lamps for comparative tests e carried out at the Mines Department Lamp ing Station of (1) lamp fitted with the present dard gauzes (28 mesh), and (2) similar lamps fitted t gauzes having 20 meshes to the linear inch. By direction of the Secretary of Mines, the Super- dent Testing Officer's report on these tests has been printed.

e tests carried out consisted in the main of hotometric tests; (2) tests in a still explosive osphere, and (3) gallery tests in a current of the explosive mixture of petroleum, ether, and air.

e photometric tests which were made by a sen disc photometer against a one candle-power dard pentane lamp yielded the following results:

Average Candle-power given by various Types of Flame Safety Lamps.

Type of Lamp.	Candle-power with 28 mesh Double Gauzes.	Candle-power with 20 mesh Double Gauzes.	Average Increase in Candle-power.
			Per cent.
Marsaut	0·62	0·82	32·3
Marsaut with short inner metal chimney	0·70	1·01	28·0
Marsaut deflector	0·71	0·85	19·7
Marsaut deflector with short metal chimney	0·77	0·94	22·1
Marsaut with inner metal chimney and inner glass	0·89	1·10	12·2
Bottom feed with bottom air admission ring	1·05	1·20	14·3
Air feed from middle ring to below the wick	1·80	1·85	3·0

From statistics published in the Final Report of the Miners' Lamp Committee it would appear that in the event of the new gauzes being adopted, approximately 402,000 Marsaut type lamps would obtain the benefit of an average increase of 32·3 per cent. in candle power, whilst 182,000 lamps of other types would benefit by an average increase of 16·1 per cent. in candle-power.

Although the Safety Tests were of a most severe character, none of the lamps submitted failed to pass the test satisfactorily, and Capt. Platt, the Superintending Testing Officer, is of the opinion that the factor of safety under test conditions is sufficiently great with the 20-mesh gauze.

[1] eport on Tests of Miners' Flame Safety Lamps fitted with Open Mesh us, carried out at the Mines Department Lamp Testing Station, kcals, by Capt. C. B. M. Platt. (London: H.M. Stationery Office.) 3d.

The British Dyestuffs Corporation.

TWO important pronouncements regarding the present position of the British Dyestuffs Corporation appeared in the press last week. In a written reply to a question put in the House of Commons by Mr. Graham White, the President of the Board of Trade, Mr. Sidney Webb, said: "The Board of the British Dyestuffs Corporation have been informed that the Government would feel compelled to exercise their power of veto with respect to an agreement with the Interssen-Gemeinschaft on the lines suggested."

In making this decision, the Government has taken the only course consonant with national welfare and with the best interests of the textile industries. The question of the agreement has never been specifically before the shareholders of the Corporation, but it has been for some time abundantly evident that the views and policy of the directors and of the financiers who hold large blocks of shares were opposed to the considered opinions of all the important industrial and scientific organisations concerned.

In view of the Government veto, other methods of dealing with the present unfortunate position of the British Dyestuffs Corporation must be necessarily explored, and definite alternative proposals are not lacking. In his recent address as chairman of the Colour Users Association, Mr. Sutcliffe Smith made proposals for the reconstruction both of the financial and management sides of the Corporation, and, speaking before the Society of Dyers and Colourists in Bradford on October 9, Dr. Herbert Levinstein, who has been engaged in dyestuff manufacture all his life and is also probably the largest individual shareholder in the British Dyestuffs Corporation, subjected the position of the Corporation to a critical examination.

According to the *Times*, October 10, Dr. Levinstein said: "Last April, at the annual meeting, the chairman stated that the board would resign if they were not encouraged to complete the agreement as outlined. The colour consumers, the customers of the company, through the chairman of their association, have definitely stated that they disapprove of the agreement, that they will prevent it if they can, and will welcome an entire reorganisation of the management. Further, the agreement, the headings of which have become known, is opposed by every one of the organised bodies in Great Britain representing pure and applied chemistry, including the Association of British Chemical Manufacturers. Thus it appears that the policy of the board and the constitution of the board are disapproved by the whole of the chemical world and by their customers, the colour-using interests. Out of much that is obscure this much is certain. The agreement has not been approved. The situation contemplated by the chairman and his colleagues has arisen. The board have not been encouraged to complete the arrangements with the I.G. in which they put their faith, and they will no doubt tender their resignations." At the annual meeting of the Corporation last April, several speakers, men of high standing in the City of London, who represented substantial financial interests in the company, supported both the board and the agreement. The public flotation of the Corporation was not a success, a large proportion of the shares remained, and apparently still remain, with the underwriters, and Dr. Levinstein viewed with concern this divergence of views between colour users and those who represented the underwriters.

The position is one of great gravity as regards the future of the British Dyestuffs Corporation. The problems imposed on the directors by inherent difficulties of the position have not been solved by the proposals, and it has been shown once again that the special conditions involved in chemical manufacture in general, and in dyestuff manufacture most particularly, cannot efficiently be dealt with by a board which bases its policy on financial, rather than technical requirements. The improbability of the success of any dyestuff concern managed on these lines was predicted by Lord Moulton and others, and strong but unavailing appeals were made in NATURE and elsewhere that the directorate should contain a strong technical element.

The solution of the present lamentable position appears to be a drastic reorganisation of the British Dyestuffs Corporation's finances and policy, coupled with an all-British, instead of a German-British agreement. It is stated that British firms outside the Corporation are at present supplying three or four times as much dyestuff to British consumers as does the Corporation, and are, in fact, its chief competitor.

WALTER M. GARDNER.

University and Educational Intelligence.

BIRMINGHAM.—The following appointments have been made: Mr. Robert H. Kinvig to be reader in geography; Mr. Launcelot P. Timmins to be lecturer and demonstrator in oil production in the Department of Oil Mining; and Mr. W. J. Shearer to be lecturer in coal mining and mine rescue work. Dr. Beatrice Webb has been appointed medical officer to the Women's Training Department in the place of Miss Olive Elgood Turner, who has resigned.

Under the title "Careers to which subjects may lead, and other information," the Faculty of Science has issued a booklet "for the guidance of those who intend to enter the Faculty of Science of the University, and for the information of Heads of Schools, Parents and Guardians concerned." This publication, for which there is already a considerable demand, sets forth the qualifications desirable in any one about to enter the Faculty of Science, great stress being laid on the necessity of a sound knowledge of English. Some knowledge of physics is regarded as essential in all subjects, and an acquaintance with German is strongly advised. An indication is given of the careers which are open to successful students in the various departments, and the pamphlet should be of great value in enabling intending undergraduates to decide upon the subjects to which they can most advantageously devote their time at the University.

BRISTOL.—An agricultural chemist is shortly to be appointed to assist in advisory work in the Bristol province under the advisory scheme of the Ministry of Agriculture. Particulars may be obtained from the Registrar of the University. Applications for the post should reach the Registrar not later than October 25.

CAMBRIDGE.—The new year finds the college busily occupied with the drafting and passing of statutes to meet the recommendations of the recent Royal Commission and the requirements of the Statutory Commissioners. So far the University has not been asked to devote much time and labour to the task of drafting statutes and ordinances, save for the new pension statutes, which will bring its future staff, and, so far as possible, its present staff, within the Federated Superannuation System for universities. It would, however, seem inevitable that when

the Commissioners come to grips with the detailed requirements of the Faculty Scheme, the provisional outlines of which have been already reported in these columns, the co-operation of the resident teachers must be sought. University and college officers alike look forward to a busy year, which will, in many matters, be of vital importance in the history and development of the University.

The department of the University which looks forward to immediate development is that of pathology owing to the generous endowment for a new laboratory by the Rockefeller Trustees and Mr. Ernest H. Gates. Building is also to be done for the Animal Diseases Institute and for an extension of the School of Agriculture. New college buildings at Jesus and Sidney Sussex Colleges will also soon be completed, the former being occupied this term. From all accounts the number of students is to remain at the same high level as in recent years, and the pressure on laboratories and on college accommodation is to remain very heavy.

Mr. T. M. Cherry and Mr. J. H. Quastel, research students, have been elected to fellowships at Trinity College.

LONDON.—The final report of the Royal Commission on University Education in London was dated March 25, 1913, and it is suggested that some modifications of its provisions may be desirable. The president of the Board of Education has therefore appointed a committee "to indicate what are the principal changes now most needed in the existing constitution of the University of London and on what basis a Statutory Commission should be set up to frame new statutes for the University." The committee is constituted as follows: Lord Ernle (chairman), Sir Robert Blair, Dr. H. L. Eason, Mr. H. B. Lees-Smith, Sir Henry Miers, Prof. A. F. Pollard, Sir Amherst Selby-Bigge, Bt., Miss K. Wallas, and Mr. S. H. Wood (secretary, to whom all communications should be addressed at the office of the Board of Education, King Charles Street, Whitehall, S.W.1.

At an extraordinary meeting of the Senate held on October 9 to consider a communication, dated September 15, 1924, from the president of the Board of Education with reference to the appointment of a Departmental Committee on matters connected with the University, the following resolution was unanimously carried: "That the president of the Board of Education be respectfully reminded that the Senate was not consulted as to the reference to the Haldane Commission, nor represented upon it, nor gave evidence before it; and that, having regard to the successful progress of the University since the report of that Commission, the Senate is of opinion that such changes in the organisation of the University as are necessary may be more readily effected by amendments promoted by the University than by a statutory revision of the University as constituted by the Act of 1898; but that the Senate will be prepared to furnish through its officers and appropriate Committees any information desired by the Departmental Committee, and trusts that the various bodies and interests represented on the Senate will receive a full opportunity of putting individually or collectively before the Departmental Committee their views on the matters under consideration."

The Semon lecture for the present year will be delivered at the Royal Society of Medicine, 1 Wimpole Street, W., at 5 o'clock, on Thursday, November 6, by Dr. D. Guisez, of Paris, who will speak (in French) on "Malignant Disease of the Gullet." A course of four lectures on "Enzymes" will be given by Prof. J. Mellanby on November 6, 13, 20, and 27 at St. Thomas's Hospital Medical School at 4.30 each day. No tickets will be required either for the Semon lecture or the course on "Enzymes."

ST. ANDREWS.—At a meeting of the Court held on September 7, it was unanimously resolved to appoint Mr. J. N. Wright, at present assistant in the department of logic in the University, to the lectureship in logic and psychology in University College, Dundee, and the United College, St. Andrews; which became vacant upon the appointment of Prof. Morrison to the chair of moral philosophy. Mr. Wright, who is a graduate of the University of Durham, has been assistant in the department of logic in the University since 1920.

At a meeting of the University Court on September 29, Dr. O. R. Howell was appointed lecturer in chemistry in University College, Dundee, in succession to Dr. J. S. W. Boyle, lately appointed headmaster at Prestonpans. The following nominations of assistants were approved: botany (St. Andrews), Miss C. I. Kean; chemistry (Dundee), Mr. C. A. Kerr; mathematics (Dundee), Miss Mary C. Simpson; chemistry (St. Andrews), Mr. G. J. Robertson. Mr. G. B. Steele was appointed lecturer in civil engineering and structural design, University College, Dundee.

It was intimated at the meeting that the arrangements are now complete for carrying on in Dundee a course of lectures during the coming session in railway geography, intended for the staffs of the railway companies, the lecturer being Mr. D. E. I. Innes.

The degree of Ph.D. has been conferred on Mr. G. J. Robertson for a thesis entitled "Investigations on Cellulose," and on Mr. R. S. Vaidyanathaswamy, of Madras Province, for a mathematical thesis entitled "Contributions to the Theory of Apolarity."

SHEFFIELD.—The following appointments have been made: Miss Alice Garnett, to be assistant lecturer in geography; and Dr. R. Platt and Dr. C. W. A. Lister, to be demonstrators in physiology.

ACTIVE efforts are being made to raise the sum of 20,000*l.* for necessary extensions of Queen's College, London. The chairman of the general committee is Lord Askwith, and a distinguished body of patrons is supporting the appeal. Donations amounting to 7000*l.* have already been received, and it is hoped that the remainder of the sum required will be forthcoming from old students of the College or benefactors interested in the higher education of women. The Duchess of York has graciously consented to visit the College on Saturday, November 1, and to receive purses collected for the extension fund. Queen's College was established in 1848 and incorporated by Royal Charter in 1853. It was the first college for women, and remains as independent to-day as it was when first constituted by F. D. Maurice, R. C. French, Charles Kingsley, Sterndale Bennett, D. T. Ansted, Edward Forbes, and other leaders in different departments of progressive thought. For some years the work of the College has been carried on without adequate accommodation or equipment, yet its record for scholarship and inspiring teaching is remarkably high. There should not be much difficulty in securing the relatively modest sum required to enable the College to maintain a worthy place among institutions for the higher education of women. Contributions to the appeal fund should be sent to the hon. treasurer, Sir James Williamson, or to Mrs. Allport, at the College, 47 Harley Street, London, W.1.

Early Science at the Royal Society.

October 19, 1664. Dr. Merret brought in his catalogue of trades, which was read and approved of; and it was ordered, that the amanuensis should fairly transcribe it against the next meeting, and that then it should lye exposed, at the time of the meeting of the society, for the several fellows to look it over, and to choose what trade they would give or procure the history of.—Mr. Hooke said he had observed, that upon the fall of the mercury wet weather followed.—Sir Paul Neile renewed his former motion of observing the figure of the sun at his rising and setting, both at Whitehall and Greenwich. Sir R. Moray was desired to observe it at Whitehall, and to recommend the observation of it at Greenwich to Mr. Marre.

1674. Mr. Hooke acquainted the council, that Sir Jonas Moore had been with him at Chelsea College, and made an overture of engaging a gardiner, a sufficient man, to take a lease of the house and land about it, and paying a yearly rent; allowing withal to the Society to make hortulan experiments there; as also to build an astronomical observatory, which latter Sir Jonas Moore would undertake to do at his own charges, to the value of an hundred and fifty or two hundred pounds.

October 21, 1669.—A Latin letter from Signor Malpighi was read acknowledging the favour of election, and in causing his discourse on the silk-worms to be printed.—Thomas Willisel the botanic traveller, employed by the society, brought in his collection of plants gathered in several parts of England and Scotland, together with some rare Scottish birds and fishes.—The lord bishop of Chester acquainted the society, that his Majesty had expressed a desire of having the measure of a degree of the earth determined, and expected the assistance of the society in it.

October 22, 1662. Dr. Merret mentioned, that live worms are sometimes found in the stomachs and guts of salmons. He was desired to make some observations in those and other fishes. This gave occasion of discoursing upon what is called equivocal generation.—Dr. Charlton brought in his papers, in which he had reduced birds into certain families, in Latin and English; which papers were ordered to be kept; and the doctor was desired, in conjunction with Dr. Merret, to reduce fishes into the like classes.

1668. There was presented from Mr. Hevelius his "Cometographia," wherein he takes particular notice of the society in his address to the reader.

October 24, 1666. It was moved that the materials for building, and the several sorts of earth for making brick and tile, might now be considered by the society; who were desired to think upon it against the next meeting.—A paper communicated by Sir Theodore de Vaux was read concerning several ways of making cheap and sweet fires of coal-balls wherein sea-coal is by the mixture of other combustible bodies both sweetened and multiplied.—Sir Robert Moray presented the society for the repository with some stag's tears.

1667. The method of transfusing blood into a man, as it was contrived by Dr. King was read and ordered to be registered.—It being moved, that the experiment might be made accordingly, as it had been done already in foreign parts, Sir George Ent suggested, that he thought it most advisable to try it upon some mad person in the hospital of Bethlem. This being seconded by divers other physicians of the society, Dr. Lower [and others] were desired to speak with the physician to Bethlem, about the execution of this trial.

Societies and Academies.

MANCHESTER.

Literary and Philosophical Society, October 7. Miss Laura **Start**: The significance of some Ib textile designs.—J. **Walton**: On the existence liverworts as fossils in the Carboniferous rocks England. Dr. Lucy Wills has described some sma dichotomously branched thalloid plants in shales Upper Coal Measure Age in Staffordshire and su gested that they might possibly be fragments of Bryophyte. Some clayey shale from the Middle Co Measures of the Denbighshire coal-field yielde thalloid plants of a similar type of organisation, som with rhizoids attached. In addition, two fragmen of a plant which cannot be other than a folios liverwort were isolated by treatment of the sam shale. This latter plant is distinctly dorsiventra There are two rows of leaves, one on each side of th somewhat stout axial part of the shoot. The membe of the two series alternate. On the under (or th upper ?) surface of the axial part are two rows c smaller leaf-like appendages, each in definite relatio to one of the larger leaves and lying close to it. Thu it is now clear that there were both thalloid an foliose forms of liverworts in existence in Carbon iferous times.

PARIS.

Academy of Sciences, September 15.—M. Emil Roux in the chair.—Henry **Le Chatelier**: Th viscosity of glass. A discussion of the experiment of E. Washburn and E. Shelton on the viscosities c soda lime glasses. These authors give their result in graphical form, but it is shown that the results c these measurements can be very exactly represente by the double exponential formula: Log (log η $= -Mt + P$, in which η is the viscosity, t the tem perature, and M and P constants. Exterpolatio to the annealing temperatures, 500° C. to 600° C. gives results not in agreement with earlier work and it is suggested that glass, like sulphur, exists i two allotropic states.—W. **Abbott**: The breaking u of the southern polar cap of Mars. A description o the changes in the shape and appearance of the pola cap between May and August 14 of this year.— L. **Dunoyer** and P. **Toulon**: The interpretation o the sheath phenomena in arc relays.—H. **Robert** P. **Vernotte**, and A. **Jeufroy**: The measurement o the heating of the brushes of electrical generators The advantages of using a thermocouple instead o the conventional mercury thermometer are demon strated: the differences are magnified when the size of the dynamo is reduced.—E. **Hultén**: The origin of the band spectrum of mercury. There is some evidence, not quite conclusive, that the bands are due to the formation of some compound of the metal with hydrogen. The bands are more intense when a current of hydrogen at low pressure (1 mm.) is passed through the tube, whilst a current of air has the opposite effect.—P. **Vaillant**: The conductivity of solid salts at high temperatures. The con ductivity of solid sodium chloride first increased, then fell sharply. At 150° C. there was a rapid increase to the highest temperature employed (420° C.). On reheating, the initial rise and fall were not repeated, but the increase from 150° C. was the same as on the first heating. Potassium sulphate and chloride behave similarly.—P. **Loisel**: The radioactivity of the granites from Guérat, near Bagnoles-de-l'Orne. Study of emilium. The study of the gases dissolved in the water of a certain number of springs in the Bagnoles-de-l'Orne region led the author to conclude

hese gases contained, in addition to the radium ...tion, a new emanation (period 22 minutes). ...e ranites, treated by the method of Strutt and ...gave a gas the curve of which differed from the ...teristic curve of the radium emanation.— ...ult and A. **Funke**: The alkylidene-dibenzoyl- ...ic esters.—A. **Němec** and K. **Kvapil**: The ...osition of forest soils. Analyses of soil layers ...erent depths in forests of epicea, oak, and pine, ...lata including acidity, organic matter, and ...en.—**Lesné** and **Vagliano**: The production of ... milk with antirachitic properties. The addi- ...f cod-liver oil to the food of a cow modifies ...mposition of the milk and butter. The butter ... in lecithine and the growth vitamin. The ...chitic factor present in the butter is not identical ...vitamin A.—G. **Mouriquand**, Paul **Michel**, and ...erheim: New researches on the sensibilisation ... guinea-pig to C-avitaminosis. After an attack ...perimental scurvy, the guinea-pig is more ...sive to a second attack. This condition is not ...rnent, and slowly disappears. It is not funda- ...ully a true sensibilisation, and is closely con- ...d with the long persistence of lesions only ...le of detection by histological methods.— ...arat and J. **Painlevé**: Constitution of the ...lasm of a glandular cell: the cell of the salivary ...s of the larva of the Chironome.—Auguste ...ère: The mechanism of anaphylactic shock. ... to the criticisms of M. Bordet, maintaining ... lequacy of the author's flocculation theory.

ROME.

Royal Academy of the Lincei, June 15.—V. Scialoja ... chair.—M. **La Rosa**: The ballistic principle and ... elocity of light, and recent investigations by ...iph Tomaschek.—A. **Piutti** and Pasquale **Bado- ...o** Action of light on solutions of certain organic ...bances in chloropicrin. Although chloropicrin is ...le in the dark, it undergoes decomposition when ...ed to light, and the products thus formed exert ... issolved compounds either a chlorinating, an ...ising, or a substituting action; in some instances ... itro group is reduced to the ammonium group, ... separates as chloride or oxalate.—Gaetano ...vreto: Tectonic conditions of the Circean Prom- ...ty [of the Apennines].—Francesco **Tricomi**: ...erical resolution of Fredholm's integral equations. ...a **Zanoni**: Extension of Hadamard's equation ... ...e functional derivatives of Green's function to ...scity.—Luigi **Amoroso**: Mathematical theory of ...nities.—Bruno **Finzi**: A noteworthy class of fluid ...ons.—Emilio **Adinolfi**: Hall's effect in bismuth ...te case of weak fields. In the case of bismuth, ... alue of Hall's coefficient varies linearly with the ...gth of the magnetic field and exponentially with ... emperature.—Vasco **Ronchi**: Study of optical ...sms by means of the biprism and Fresnel's ...rs.—Mario **Amadori**: Hydrated active tartaric ... At temperatures below about 5°, tartaric acid ...rates from aqueous solution in a monohydrated ..., which crystallises in blunt prisms belonging to ...hombic system and gradually changes to the ...ary anhydrous crystals at temperatures above ...ct 10°.—L. A. **Herrera**: Imitation of nervous ...cellular tissue by means of potassium hydroxide, ..., and alcohol.—C. **Mazzetti** and F. De **Carli**: ...tivity of boric anhydride in the solid state with ...llic oxides. The borates of various metals may ... obtained by heating the corresponding oxides with ... anhydride at temperatures below those at which ...respective mixtures undergo fusion.—G. R. **Levi** ... A. **Ferrari**: The crystalline lattices of the ...bohedral carbonates of divalent metals.—S. **Ranzi**: Increase of the surface and increase of the volume during the development of the otocysts of Bufo. In the development of these otocysts, the increase in the surface does not always proceed *pari passu* with the increase in the volume. At certain periods of the embryogenesis there is predominance of the former, expressed by demarcation of the parts and by slight wrinkling of the walls, whilst at other periods increase of the volume, indicated by disappearance of the demarcation and by a tendency of the organ to become spherical, assumes ascendancy. —G. **Fadda** and I. **Schiacchitano**: The significance of the polar groove in relation to that of the diameter of the fertilisation membrane.—M. **Topi**: Existence of various species of vine Phylloxera, and the susceptibility of American vines to Phylloxera. Like Arizona vines suffering from Phylloxera, infected roots of Italian vines seem unable to impart this disease to American vine varieties.—G. **Cotronei**: The phenomenon of contraction in relation to sexual maturity and to senescence in Petromyzon. Although these organisms persist sexually immature for several years, the senescent phase, expressed by a profound atrophy, occupies only about a month, during which period the animal is used up by the activity of the reproductive elements.—C. **Artom**: Variation in the radio-sensibility of the cellular elements in pecilothermic organisms. The results of Packard's recent work on the susceptibility of cells to radium emanations fully confirm the conclusion drawn by the author from his experiments on *Paludina vivipara*: that in cold-blooded organisms the radio-sensibility of the cellular elements varies considerably with the temperature and that such organisms therefore constitute excellent material for determining the exact relationship between temperature and cellular radio-sensibility.—C. **Verdozzi**: Modifications of certain internal secretory glands (suprarenal capsule, thyroid, ovary, spleen) during lactation.

SYDNEY.

Linnean Society of New South Wales, August 27.— Mr. J. J. Fletcher, vice-president, in the chair.— T. **Steel**: The nectar of flowers. Direct observation of the disappearance of nectar from protected flowers shows that, when not removed by birds or insects, this secretion is soon re-absorbed by the plant, apparently going to nourish the growing ovary. This may be the original purpose of nectar secretion in general. There are great differences between the densities of nectar as it occurs in flowers, and of honey in the comb. In the flowers examined the total sugar in the nectars varied between 9·05 and 41·20 per cent. Each species appears to have a fairly constant nectar density.—T. Harvey **Johnston**: An Australian caryophyllæid cestode. The paper describes the structure and relationships of the first caryophyllæid cestode to be described outside Europe, Asia, and North America, making the eighth species known in the family. A new genus is proposed to receive it. The parasite is noteworthy as being the first member of the family known to parasitise fish other than cyprinoids, its host being the jewfish, *Tandanus tandanus* Mitchell, a siluroid, from Queensland rivers.—J. R. **Malloch**: Notes on Australian Diptera. No. iv. Notes on the families Drosophilidæ and Chloropidæ, eight species being described as new in the former, and two genera and six species as new in the latter.—P. D. F. **Murray**: The motor nerve-endings of the limb muscles of the frog (*Rana temporaria*) and of the muscles of the pectoral fin of the dog-fish (*Squalus acanthias*). The nerve-endings were impregnated by the Bielschowsky method. Two kinds of motor nerve-endings are

described in the limb muscles of the frog, one coarse, one fine; the latter may be the sympathetic innervation. In connexion with the motor nerve-endings in the muscles of the pectoral fin of *Squalus acanthias*, at least two types of periterminal network are described, and another terminal organ in the sarcoplasm under the end-ring, which seems not to have been described hitherto.—J. M. **Petrie**: Studies in plant pigments. Part ii. The red pigment induced by insect injury in *Eucalyptus stricta*. Leaves of *Eucalyptus stricta* were found to be injured by a microscopic mite, and, as a result, great fasciation had taken place, and a bright red colour produced. The colouring matter of these red fasciated leaves was isolated and examined chemically. No trace of anthocyanin could be identified, but instead, the pigment was proved to be a catechol tannin red. It was obtained in red non-crystalline flakes, and soluble in alcohol and alkalies. The red pigment is probably one of the first anhydrides, or soluble phlobaphenes, of a catechol tannin.

Official Publications Received.

Proceedings of the Royal Society of Edinburgh, Session 1923-1924. Vol. 44, Part 2, No. 20: The Magnetic Quality of very Pure Nickel. By Ada M. Malcolm. Pp. 206-210. Vol. 44, Part 3, No. 21: The Law of Recurrences and Decay of After Images. By Winifred J. Smith. Pp. 211-217. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.) 9*d*. each.

A Verbatim Report of a Meeting of the National Advertisers Dept. of the International Advertising Convention held at Conference Hall No. 1, Palace of Industry, British Empire Exhibition, Wembley, on July 15th, 1924. Subject: Truth about Circulation. Pp. 36. (London: Incorporated Society of British Advertisers, Ltd., 134 Fleet Street.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 503: Surface Water Supply of the United States, 1919 and 1920. Part 3: Ohio River Basin. Pp. vi+257+2 plates. (Washington: Government Printing Office.) 25 cents.

University of London, University College. Calendar, Session 1924–1925. Pp. lxviii+10+441+lxix-clxxx. (London: Taylor and Francis.)

Diary of Societies.

SATURDAY, OCTOBER 18.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 4.—Sir Archibald E. Garrod: Harveian Oration.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital), at 4.—E. D. Adrian: The Reflex Electric Response of Antagonistic Muscles.—Ff. Roberts: The Short-circuited Circulation.—J. Mellanby: The Action of Digestive Enzymes on the Red Cell.—J. F. Fulton: Alterations in the Size of the Electrical Responses of a Muscle Fibre produced by small Alterations in Tension.—D. T. Barry: Some Points in the Formation of a V-wave in the Venous Pulse.—R. J. S. McDowall and B. L. Worsnop: The Effect of Histamine on the Aorta of the Living Animal.—J. Barcroft, C. A. Murray, and I. Sands: The Effect of Splenectomy on Coal-gas Poisoning.—I. Sands: Self-oxidation in the Blood of the Earthworm.—J. M. H. Campbell, G. O. Mitchell, M. S. Pembrey, and A. T. W. Powell: The Effect of Muscular Work upon Digestion.—M. S. Pembrey: The Weight of the Heart in Different Conditions.—A. N. Drury: The Spread of the Excitatory Process in Auricular Muscle subjected to Pressure.—A. N. Drury and E. C. Andrus: The Influence of Hydrogen Ion Concentration on the Mammalian Auricle.—Demonstrations.

BIOCHEMICAL SOCIETY (at Cambridge).

MONDAY, OCTOBER 20.

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (at Queen's Hotel, Leeds), at 7.—Annual General Meeting.

JUNIOR INSTITUTION OF ENGINEERS (North-western Section) (at 16 St. Mary's Parsonage, Manchester), at 7.15.—G. E. Blyth: Powdered Fuel.

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court, S.W.), at 8.

TUESDAY, OCTOBER 21.

ROYAL HORTICULTURAL SOCIETY, at 4.—Lecture.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting of Fellows.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the months of June, July, August, and September.—Prof. H. M. Lefroy: Exhibition of lantern-slides illustrating the life-history and habits of the Death-Watch Beetle.—R. I. Pocock: The External Characters of the South American Edentates.—Rev. Dr. F. J. Wyeth: The Development and Neuromery of the Fore-brain in Sphenodon.—H. C. Abraham: Some Mygalomorph Spiders from the Malay Peninsula.—Joan B. Procter: Unrecorded Characters seen in Living Snakes and Description of a new Tree-Frog.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—Sir James Kemnal: Tendencies in Steam Generation.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre the College, Loughborough), at 6.45.—F. W. Nicholls: Realisa Heat Units in Steam and Electric Power Plant.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. A. T Old English Country Homes.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Cov at 7.15.—Dr. W. R. Ormandy: Research (Presidential Address).

INSTITUTE OF CHEMISTRY AND SOCIETY OF CHEMICAL INDUSTRY (Edi and East of Scotland Section) (at 36 York Place, Edinburgh).—W Woolcock: Opening Address.

WEDNESDAY, OCTOBER 22.

FARADAY SOCIETY, GEOLOGICAL SOCIETY, AND MINERALOGICAL S (at Geological Society), at 3.—Dr. J. S. Flett: Introductory Add Dr. G. W. Tyrrell: Review of Recent Work on the Origin and Diffe tion of Igneous Rocks.—Prof. W. E. S. Turner: The Physical Pro of Silicate Glasses.—A. F. Hallimond: The Formation of Eutect Similar Structures in Silica Melts.—Prof. J. W. Gregory: Ma Ore Deposits.—Dr. J. W. Evans: Proposed Researches in the Che and Physics of Igneous Magmas Rocks.—Prof. C. H. Desch Theory of Crystallisation in Rock Magmas.—Dr. A. Scott: Equili of Igneous Rocks and the Influence of Certain Factors on it.—P Niggli: Homogeneous Equilibria in Magmatic Melts and their B on the Processes of Igneous Rock Formation.—Dr. W. A. Richa Some Ultimate Problems in Petrogenesis.

INSTITUTION OF ENGINEERING INSPECTION (at Royal Society of A 5.—A. Hamilton: Crankless Engines.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Cent 244 Deansgate, Manchester), at 6.30.—Dr. W. R. Ormandy: Re (Presidential Address).

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Hotel, Birmingham), at 7.—W. Lawson: Chairman's Address.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Sectic 7.30.—J. E. Barnard: The Elementary Principles of Microsc Illumination—(1) Transmitted Light.—Dr. R. H. Greaves: saturated Solid Solutions.—H. Wrighton: New Photo-microg Apparatus for all purposes.

THURSDAY, OCTOBER 23.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Grou Engineers' Club, Coventry Street, W.C.), at 5.—H. Griffiths: C lisation.—T. V. Barker: The Development and Formation of Cry

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—W. B. Woodhous augural Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Luton Centre) (at Luton), G. L. Ensor: Positive Valve Control.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND R PROGRESS (at Essex Hall, Essex Street, W.C.), at 8.—Dr. Marie S The Present Position of the Birth Control Movement (Presid Address).

INSTITUTION OF WELDING ENGINEERS (at Engineers' Club, Co Street, W.), at 8.—E. A. Atkins: Steel Wire: its Manufa Properties, and Uses for Welding and other Purposes.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Ch Street, W.), at 8.15.—Sir Malcolm Watson: Observations on M Control with special reference to the Assam Tea Gardens.

FRIDAY, OCTOBER 24.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science Technology), at 5.—D. Gunnaiya and G. Subrahmaniam, with D stration by D. J. Blaikley: Underblown Pipes.—W. Mandell J. West: The Temperature Gradient in Gases at Various Pressu J. F. S. Ross: Vectorial Dimensions.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur K Anatomy and Malformations of the Heart (2). Specimens illusti the common kinds of Congenital Malformation.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. E. Saun "Close-ups" at the Zoo.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—F. F. Evans: Pow Fuel.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUI (Middlesbrough Branch) (at Cleveland Institution), at 7.30. McGovern: Address.

PUBLIC LECTURES.

SATURDAY, OCTOBER 18.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Dewey: Cornish Sc and its Causes.

MONDAY, OCTOBER 20.

KING'S COLLEGE, at 5.30.—Prof. E. W. Scripture: Prose and analysed by the Newer Methods.

TUESDAY, OCTOBER 21.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Prof. H. Piéron: La Dou au point de vue des fonctions affectives et perceptives (in Fren (Succeeding Lectures on October 22, 24.)

GRESHAM COLLEGE, at 6.—W. H. Wagstaff: Geometry (Gresham Lect (Succeeding Lectures on October 22, 23, 24.)

SATURDAY, OCTOBER 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: Life amongst Insects—(1) Ants, Bees, and Wasps.

NATURE

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON

NO. 2869, VOL. 114]

Popularisation and Sensationalism.

THERE can be no doubt that at the present day the question of the popularisation of science has acquired new interest and importance; it has been for some time an increasingly recurrent theme in our columns. The times seem in many ways to offer a new opportunity; great things—very great things—have been occurring in science, and in view of them we realise more than ever the grievousness of our intellectual condition, a condition where not only the multitude lie in ignorance but also where those who pass as the best informed have been left by their higher education without eyes to see, or ears to hear, the greatest happenings in the progress of human knowledge.

There is, we must gladly admit, evidence of an awakening, of some growing sense of shame, and of a genuine and widespread desire to learn. Among those who direct the newspaper press, which, we are assured, reflects rather than leads public opinion, there are signs of an increasing disposition to bring science into the daily diet they provide. In a certain number of cases, science has become what is technically known as a "feature"—like the music and art columns; and it has even shown the possibility of providing at times a "scoop." Broadcasting, again, is opening up new channels of communication which, if properly used, may be of unequalled importance in creating among the multitude an intelligent interest in science.

It seems to us very important that at this juncture, men of science should be alert to seize their opportunities and that they should respond in every legitimate way to the growing demand. They should bend themselves to the task of translating science to the public and of giving all the knowledge that is possible of its meaning, its methods, and its march. We need scarcely add that the task is one of very great difficulty. The public must have what the public wants: if it desires to be informed, it demands before that to be interested. Its own point of view, its primitive state of knowledge in all that relates to science, must be carefully regarded. Liveliness of exposition is as necessary as lucidity. The thing can be done—it is well worth doing; and though it seems at present there are not many, we believe that there might, by taking thought, be many more who know exactly how to do it.

There is no doubt that many men of science shrink under the demand for popularisation, not only because it would divert them from what seems more serious work, but also because it threatens a loss of self-respect. We can all understand and sympathise with their apprehension, and it is only fair to say that to-day the position is becoming more difficult. The public

expectations of new marvels from science have been greatly stimulated; science gives a new promise of material for leaded type and heavy headlines, it may even reach the evening "contents" bill; camera-men are in waiting at every corner.

It is easy to understand the reluctance, which all this inspires in modest men, to venture on the territory of press publicity, and to incur the risk of inclusion with charlatans whose "amazing" discoveries still find so ready an acceptance there. We believe, however, that the risk is worth while and that with reasonable care the dangers can be avoided. Vigilance is, however, becoming increasingly necessary, and it is of the first importance that public opinion within the scientific world should express itself plainly when this vigilance is neglected.

It is with this sense of obligation that we feel compelled to express very great regret that, in one of the younger universities, the dignity of science should recently have been allowed to undergo what seems to us to be a very serious violation. We shall not attempt to enter into details, nor do we desire to particularise individuals. The essential fact is that a want of vigilance has led to an exhibition of vulgar sensationalism which, as we are well assured by the remonstrances that have reached us, is regarded by the reputable scientific world as being in the highest degree deplorable. We make no attempt to apportion blame; we are concerned only to enter a strong protest. It is possible that what has happened may act as a temptation to a few of the less thoughtful to the empty glories of the limelight. In so far as that is the case, it will, we trust, stir responsible people to the exercise of restraint. We do not think the chief apprehension lies in that direction. We fear rather that what has happened may prove to have given a serious set-back to the efforts, which have recently been showing more success, to induce our men of science to help in a wholesome alliance with the Fourth Estate in what, properly regarded, has the sanctity, and should have the sobriety, of a missionary effort of enlightenment. We can only hope that what has recently happened will leave behind nothing but a salutary warning.

There is at the present time great restlessness in the world; old landmarks and fixed points, and even rules of life, seem to have disappeared, and we are in the turmoil of readjustments on the grand scale. Amid the grave anxieties of this condition we have a temporary excitement breaking out here and there in all sorts of morbid forms. By coincidence we have in the world of science a corresponding stir of readjustments; let us see to it that we at least are not invaded by the discordant spirit of jazz.

The Human Factor in Coal Mining.

ON October 2 the Institution of Mining Engine held its annual meeting, at which Prof. J. Haldane was inducted into the presidential chair gave his presidential address: The occasion sufficiently unusual to merit special comment. It not an ordinary occurrence for the president of engineering institution to be a professor of physiolo but Prof. Haldane is no ordinary physiologist. He practically devoted his life to a study of the phys logical problems which the miner's occupation preser and to the discovery of how the miner's health a safety of life and limb are affected by the incidence accidents of his occupation, and how the ill-effects these can be guarded against. It is not too much say that it is to Prof. Haldane's studies that thousa of coal miners in Great Britain owe their lives and hea to-day, and that he has played a leading part in battle against the dangers of the industry which min engineers are waging with such conspicuous success t coal mining in Great Britain is safer than in any ot country in the world.

As might well be expected, Prof. Haldane's pr dential address had in it nothing at all technical; was essentially humanistic and laid stress upon t most important of all factors in any engineer industry, namely, the human element. He poin out that one of the most striking characteristics mining men is the deep and sincere feeling of comra ship that unites all classes amongst those actua engaged in mining work; or, as he put it: "I have of been present at a colliery during some time of trou or danger; and it was this comradeship, from high to lowest, that impressed me most. But whether not unusual trouble is present, one seems to meet co radeship as one enters the colliery premises or st into the cage." He points out that it is this readin with which miners "will give loyal and efficient servi will face any danger, will forgive imagined or r mistakes, and will take the rough with the smooth, t bad times with the good," that makes the miner ins upon his right to be treated as a man and not as machine; and Prof. Haldane expresses his strong vi that this feeling is really at the bottom of the so-call industrial unrest amongst miners. As he puts i "Neither high wages, high dividends, nor welfare schem will satisfy them in this respect, but only discerning a sympathetic treatment, the treatment of comradesh in a common enterprise—such comradeship as existed and between all ranks during the War, or such comrad ship as is taught in the Gospels."

Prof. Haldane makes clear that his experience h taught him that the mining engineer and mine manage

unconsciously perhaps, but nevertheless quite sincerely, to his attitude on the part of their men, and that they will sympathise with it and endeavour to give it every opportunity for expression within the limits which they find possible, having regard to the safety and well-being of the men themselves. In this sense a coal mine "is the outcome of human comradeship, which must in its own way, and of its own free will, the tools provided by physical and economic knowledge."

Throughout his address, Prof. Haldane shows clearly that he thoroughly appreciates the existence of the feelings of true cordiality, regard, and esteem which employers and employed in the coal-mining industry really entertain for each other, but which as a rule are not evident to those outside the industry, whereas the public at large, seeing only the surface of things, may well be inclined to disbelieve in their existence. Those engaged in the industry know well enough, for example, that during the recent long-drawn-out disputes, colliery owners and managers actually assisted from their funds the strikers of their own pits to tide over that period of hardship, but the general public never hears a word of such kindly actions. Constantly during the recent disputes one heard the opinion expressed by both sides in colliery districts that, if only the busybodies at headquarters would leave them alone, they could settle their own differences readily and amicably.

Prof. Haldane is one of the few who has rightly gauged the feelings of the average colliery manager and coal miner for each other, and he lays stress, as its importance deserves, upon this phase of the relations between masters and men, though he at the same time shows that coal mining must, in the interests of the nation itself, necessarily be so carried on as to be commercially remunerative to all concerned therein, and that the responsibility for seeing that the industry is thus able to pay its way rests primarily on the mining engineer. In Prof. Haldane's own words: "When we realise the actual responsibility to their fellow-countrymen of those whose duty it is to care for the financial soundness of the operations involved in British colliery undertakings, we see at once how great that responsibility is, and how important it is that sufficiently far-seeing men should bear it, and should not be suffered to be interfered with by ignorant persons, who are commonly officious in direct proportion to their ignorance."

Prof. Haldane's address is, as we have said, unique in the occasion of its delivery. It is also an outstanding example of the fact, too rarely recognised, that the scientific worker is better able than most men to see the spiritual side of human endeavour, and that no man can be a true physiologist without having at the same time a profound insight into the problems of psychology.

A Veteran's View of Modern Physics.

Atoms and Rays: an Introduction to Modern Views on Atomic Structure and Radiation. By Sir Oliver Lodge. Pp. 208. (London: Ernest Benn, Ltd., 1924.) 21*s.* net.

THE writing of a popular account of recent advances in any branch of science calls for many qualities if it is to be successful. The author must, in the first place, be able to interest and hold the reader without recourse to sensationalism, a truism which, like many other truisms, is often overlooked. He must be the master of clear and concise English, and remember that many words which have a special and defined significance for the expert have also a general meaning which is much more vague. He must have sufficient critical faculty to be able to select for emphasis the points which are really fundamental, and sufficient adaptability to feel when detail must be sacrificed for the sake of vividness. Above all, he should be able to make the reader see in the researches which he describes an example of the power and beauty of the true scientific method, as contrasted with the inspired guesswork to which the ordinary reader is apt to attribute the advances of science.

Sir Oliver Lodge possesses all these virtues, and, in addition, his own distinguished career as an investigator has left in him an informed enthusiasm which he is well able to communicate. He is a veteran who sees in the modern campaigns against the unknown a repetition, governed by the same general rules of war, of those earlier ones in which he was a leader, and he speaks with the authority of one who knows the conditions of the conflict, as against those who, having never seen the battle raging, attempt to develop an account of the hostilities from the dry despatches. Nearly twenty years ago he gave us, in his "Electrons," the best general account of the state of the electron theory at that time. Towards the end of that book he mentioned various theories of atomic constitution, and spoke of the "exaggerated uncertainty" of the position with special reference to Sir J. J. Thomson's contention that the atom of hydrogen contained only one electron. He also had something to say of the difficulties in the way of explaining line spectra. To-day he has to tell how the advances of the last fourteen years or so have brought clearness into the subject of the structure of the atom, of the quantum theory, of how Bohr's application of it has gone far to found a reasonable theory of spectra, and, in general, of the present state of the electrical theory of matter and the associated radiation problems. He appeals to a wider audience than he did in the earlier book, for very little general knowledge of physics is now assumed in the reader,

and such mathematical treatment as there is requires for its comprehension but an elementary knowledge of algebra.

The book does not present a strictly consecutive scheme, for Sir Oliver holds that, in the words of his preface, "it is only by treating a subject from many points of view, and by frequent repetition, that it gets any hold on the general mind. Effective exposition cannot be done crisply and compactly." Accordingly, in the first few chapters we find the electron, the nucleus atom, some of the fundamental facts of radioactivity, and other features of modern physics approached in different places from different points of view, a few facts and aphorisms being set down each time a particular problem presents itself. In this way the reader is gradually familiarised with the chief experimental facts and the leading speculations based on them, although, perhaps, a clearer distinction between the two might occasionally be made. We then come to the quantum theory, illustrated by simple examples from everyday life. "One cannot gain half a trick at whist." The analogy used a little later is not so good: we are asked to consider an assemblage of tuning-forks, each with a small pellet suspended so as to touch the prong. When a note of given frequency is sounded the forks of that frequency, and of that frequency only, will throw off the pellets. This is true, but it fails to represent the chief feature of the quantum theory, namely, that the energy with which the electron is flung off is, in cases governed by quantum laws, dependent on the frequency of the radiation, but not on its intensity. This is, of course, pointed out by Sir Oliver elsewhere, but the analogy is a poor one to have introduced.

A brief account of optical and X-ray spectra, followed by a resumed consideration of the nucleus atom, leads into an account of Bohr's theory of the hydrogen atom, to which a large part of the book is devoted. Sir Oliver has set out to give, in the most elementary form, the mathematics of Bohr's explanation of the simplest line spectra, and here he has been most successful. He considers in detail the problem of the simple circular orbit, and carries out the whole of the calculations by degrees over several pages, always explaining the dynamical principles as they arise in the most comprehensible way.

The treatment of heavy atoms is, necessarily, very slight. The physicist will be somewhat surprised at the sense in which the author has used the word *ionisation*, for by it he indicates the removal of an innermost, or K, electron, instead of, as is usually implied, an outer electron. For example, he says, "Even moderately heavy atoms cannot be ionised or dissociated by visible illumination, but can be disturbed by X-ray frequencies: the frequency needed to ionise an oxygen atom, for instance, should be si four times that which is sufficient to ionise hydrog It is a pity that the term *ionisation potential*, w already has a perfectly definite meaning, shoul thus reapplied to characterise a quite different q tity, while the accepted meaning of the term, w is of such importance for spectral theory, and, m over, is capable of simple exposition, is altoge neglected.

One of the questions most frequently asked by interested layman is, to put it abruptly, whether ether exists or no. The orthodox physicist of to- would, we take it, after trying to avoid the quest reply that the ether as a substance ceased to exist to be a good working hypothesis, if the expressio preferred) when the theory of relativity bec established: that we cannot speak of determin points in the ether, or measure a velocity relative t or, in short, endow it with ordinary mechanical perties. On the other hand, there is no objectio calling empty space, in which an electromagnetic exists, the ether, but to those accustomed to the substantial ether, this is much like calling a sp table without any food a meal—they ask for bread, we pass an empty plate, and tell them that they call its contents what they like. Sir Oliver wil course, have none of this; he is for the good old e with mechanical properties—*et plutôt deux fois qu' et plutôt trois que deux*. He has many interes speculations which involve its existence as a fluid suggests that it may have a structure, a textur vortices reminiscent of Descartes, and that propul may one day be achieved by a sort of reaction on massive ether. For the professional physicist, realises the spirit in which they are put forward, t suggestions and analogous speculations are ful interest, but it would have been well to warn the reader, to whose need the book is, in general splendidly adapted, of some of the difficulties in way of a substantial ether.

Again, there are certain calculations which ass that the electronic mass is unaffected by high spe calculations put forward because they lead to sugg ive coincidences. No one knows better than Sir Ol that the mass of the electron is not, in fact, constan indeed, he has clearly expounded this elsewhere— his lay reader will scarcely know what to make of th calculations. These are examples of our only gen criticism of the book, namely, that, for the ordin reader, there is too little separation of what is w established from what is fanciful speculation. T physicist will follow with delight Sir Oliver in confident, independent, and characteristically fearl excursions among the more ticklish problems of to-d

the less experienced may well wonder occasionally re he is.

hen Sir Oliver rises to speak at a scientific meeting, who know him rouse themselves from their reflec-s, or apathy, and prepare to hear some simple hs which have, perhaps, been overlooked, wittily exquisitely expressed. This book has much of the lity of his speeches: it is personal, persuasive, and sting, conceived in a broad spirit, and full of husiasm for progress made in the past, and the sibilities of the future. "The processes of Nature uld be enjoyable, even though the enjoyment is riously acquired." This sentence of his might serve motto for a volume that is characteristic of the hor, to have said which is to commend the book to ery discerning and comprehensive circle of readers.

E. N. DA C. A.

The Technique of Contraception.

Contraception (Birth Control), its Theory, History, and Practice: a Manual for the Medical and Legal Professions. By Dr. Marie Carmichael Stopes. Pp. xxiii+418+4 plates. (London: J. Bale, Sons and Danielsson, Ltd., 1923.) 12*s.* 6*d.* net.

DR. MARIE STOPES has written a very good book on birth control. Not the least of its merits is a simple directness which marks sincerity and contrasts pleasantly with the sentimental sloppiness which nauseates in many publications on the same subject. She relies on evidence, and marshals it in a clear, readable way. Given her point of view, we may differ from her on minor matters, but on the whole she compels agreement.

One cannot have one's cake and eat it too. Living things tend to multiply so fast that continuous high birth-rates and low death-rates are incompatible. High rates may coexist for ages, so may low rates; but never for long a high rate of one sort with a low rate of the other. In the end, a rapid increase of population implies a massacre of youth. On the other hand, many deaths and few births imply extinction of the race. Now and then, for limited periods and under special conditions, the demand for human beings may equal and even exceed the supply; but, as a rule, and always in the long run, the reverse is the case. Optimists tell us that Nature will provide for her children. She does—by means of war, or famine, or disease, or total hardship, or two or more of these combined. It is conceivable that the earth has resources which would maintain its present human population, multiplied a hundred- or a thousand-fold. But here we have only an ugly dream. Even if the earth, its romance and beauty gone, gradually became a great market-garden under intensive culture, its resources could not be made available fast enough. Demand creates supply; but the latter lags.

The struggle for space and existence is perhaps severest among such primitive savages as live on wild produce, which is usually scanty. Each tribe draws its subsistence from a wide area, within which it murders trespassers, and beyond which it seeks to exterminate neighbours. Contraception is known and practiced, or failing it abortion; or failing the latter, infanticide and neglect of the weak and aged. The taming of wild animals and plants increased production; and in time and for a time the labour of a robust individual gave subsistence for more than himself and his family. Thereupon wars of conquest displaced those of extermination. The strong sought not so much land and elbow-room as slaves, subjects, and tributaries. So men drew into larger aggregates. Civilisation dawned. Commerce became important. Means of communication improved. The deficiencies of one area began to be supplied from the superabundance of others. Finally, men turned more and more from agriculture to the manufacture of things which could be exchanged for food and other articles of use or luxury. During recent centuries this has been especially the case in England, where the great majority of the population is now urban.

For an epoch all went, or seemed to go, well with the British. Not only did they multiply, but wealth also bestowed power to bring food and other raw material from overseas. Presently, however, capital found insufficient opportunities for investment at home and was exported for the development of other lands. The latter soon began to manufacture and sell much they had bought in Britain, and even to export their wealth for more development elsewhere. This process cannot continue for ever. Emigration, which deprives us of some of our best human material, is almost negligible as a remedy. Apart from war, famine, and the like, no means, save contraception, of fleeing from the wrath to come can be thought of. Lacking it, the old savage wars for elbow-room must recur. Germany's struggle was nothing other. The mills of God grind slowly but they grind exceeding small.

Another line of reasoning is more decisive because more obvious. Contraception, whether right or wrong, has come to stay. In growing numbers men and women practise it in secret, and not all the king's horses and all the king's men can prevent them. In this connexion it is remarkable that the clergy, who in theory are the most determined opponents of contraception, have now the lowest, or almost the lowest, birth-rate in the kingdom. France and the United States have passed futile laws against it. During recent years the latter

country seems indeed to have developed a perfect genius for enacting edicts which cannot be enforced.

Dr. Stopes's book contains an introduction by the late Sir William Bayliss, and introductory notes by Sir James Barr and other medical people. Sir William Bayliss questions whether, as Dr. Stopes supposes, the seminal fluid contains hormones which, even in the absence of conception, are absorbed by, and are of value to, the female. The supposition is difficult to test, and Sir William's doubts will be echoed by many readers. The only experimental evidence is that furnished by John Hunter. "The semen would appear, both to smell and taste, to be a mawkish kind of substance; but when held some time in the mouth it produces a warmth similar to spices, which lasts some time." Evidently John Hunter was an intrepid experimenter! Of more than doubtful validity, too, is Dr. Stopes's belief (p. 139) "that in the fully excited uterus the cervix may spontaneously open and interlock with the glans penis." The cervix of the unimpregnated uterus is tough and gristly and its canal is many times too small for the glans.

But these and other speculations are of minor importance. The principal value of the volume lies in a careful and exhaustive discussion of the methods and technique of contraception—ancient and modern, savage and civilised, ranging from major surgical operations to simple and easily manipulated devices. Dr. Stopes's experience, gathered mainly from fertile but overburdened working women, mere drudges, alive but strangers to liberty and happiness, is so extensive that her opinions must necessarily carry weight. She condemns, except in special cases, all measures undertaken by the male, and advises in particular the use of a light rubber, dome-shaped, cervical cap. Of great value also is her history of the struggle to convey contraceptive knowledge to the public. Some such book as this had to be written, and this is very well written.

G. ARCHDALL REID.

The Sense-Organs of Animals.

Allgemeine Zoologie und Abstammungslehre. Von Prof. Dr. Ludwig Plate. Zweiter Teil: Die Sinnesorgane der Tiere. Pp. ix+806. (Jena: Gustav Fischer, 1924.) 22 gold marks.

THIS imposing and beautifully illustrated volume of about 800 pages forms an admirable text-book upon the sense-organs of animals. Its author is well known as successor of Haeckel and Director of the Phyletic Museum at Jena, as one of the most trustworthy of German writers on the philosophy of evolution, and as the author of highly important morphological researches, such as those upon the primitive gasteropods. Prof. Plate is primarily a morphologi yet he clearly recognises that evolutionary theo although its record is necessarily morphological, mu if it is to be fruitful, remain in close touch with phys logy. Indeed, his book is a good example of what t ideal text-books of general zoology in the future will in its happy combination of anatomy and physiolog

The volume contains a vast mass of detailed inform tion regarding the sense-organs, but it is no mere aggr gation of detail. On the contrary, the facts are w marshalled and fitted into an evolutionary framewo that makes the volume, large as it is, most interesti reading. It will prove of great use to the advanc student and also to those who have to lecture to a vanced students. Its perusal will prove illuminati alike to the narrow zootomist and the narrow physi logist. The latter, perhaps, accustomed to think sense-organs entirely in terms of those that happen exist in man, will have his outlook broadened l learning such facts as that within the group of insec alone, auditory organs have evolved independently i at least eight different methods out of the primiti sensory cells.

The volume is divided into fifteen chapters, deali respectively with general introductory matter, tacti and other skin sense-organs, lateral line organs, grav tational sense-organs, auditory organs of Invertebrate auditory organs of Vertebrates, temperature organ organs of smell and taste, physiological effects of ligh eyes of Invertebrates, general review of these, colou perception, eyes of Vertebrates, pineal organs, an general principles of the evolution of sense-organs.

The introductory chapter deals with basic matte such as the classification of sense-organs, the variou types of cell, sensory and accessory, which enter into th composition of sense-organs, and the various arrange ments for receiving and transmitting the sensor stimulus. The following chapters, constituting th main part of the volume, deal with the various sensor apparatuses in detail. The mass of information is fa too great for detailed notice in a short review; eac chapter constitutes an excellent survey of its particula subject-matter. A particularly interesting one is tha dealing with the auditory organs of terrestrial inverte brates. Thus about 25 pages are devoted to these organ as they occur in insects. The structural arrangement of chordotonal organs are first described, their functio being regarded as that of the detection of simple vibra tions. The various types of auditory organs are re garded as evolutionary developments from chordotona organs, the original function of perceiving simple vibra tions, possibly in correlation with control of win movements, having become specialised in the directio of appreciating sound. Such organs are seen in th

ranic organs present in cicadas, crickets, grass-
pers, and many sound-producing Lepidoptera, the
x, in each of these types of insect presenting
aracteristic peculiarities in detail which suggest that
e have evolved independently from the ancestral
hordotonal organ. Ignoring such differences in detail,
he tympanic organ consists of a piece of body-wall so
ined out as to form a delicate vibratile membrane
parating the outer air from an internal air-filled cavity
ormed by the dilatation of a tracheal trunk, and having
n nation to it peculiar sensory cells of the same type
s those seen in the chordotonal organs.

The succeeding chapter gives an interesting account
of the vertebrate type of auditory organ. The author
follows the fashionable practice of using the word
tal cyst rather than otocyst. This practice is, on the
whole, to be regretted. Either name is no doubt in
itself beyond criticism, but otocyst has an important
practical advantage in teaching, inasmuch as it brings
the less familiar type of organ and function into
relation with the more familiar instead of conversely.
It is also perhaps to be regretted that the author has
not simply ignored the sterile morphological contro-
versy regarding the homologies of the malleus and
incus of mammals. Morphologists of the future will
undoubtedly marvel at the greatness of the faith of
those who have regarded the developmental pheno-
mena exhibited by malleus and incus in the embryo,
and the palæontological facts which have been inter-
preted in accordance with them, as being of weight
sufficient to overcome the physiological improbability
of (1) new skeletal elements becoming intercalated in
a structure which must have been freely movable
throughout its functional history, and (2) the articula-
tion between jaw and skull being replaced by another
one without break of functional continuity. Apart
from such matters of opinion, the chapter gives an
excellent account of the vertebrate otocyst and its
variations, illustrated by a wealth of admirable figures,
among which we are glad to notice Gray's beautiful
photograph of the otocyst of Echidna.

In a work on the sense-organs, some of the most
interesting chapters are naturally those which deal with
sight. In this volume they occupy about half of the
whole. A general discussion is first given of the relations
of light to living processes. While the work of Loeb is
fully appreciated, Plate is more cautious than many in
following this author, and he does not forget to mention
Szmanski's interesting experiments on cockroaches,
which he succeeded in teaching them to avoid dark
corners by associating with darkness the idea of electric
shocks! The detailed description of the various types
of eye met with in the invertebrata occupies about 170
pages; it will be of the greatest utility to advanced
students desiring to have a comprehensive grasp of
eye-structure in all its varieties. A good chapter on the
eyes of vertebrates is followed by a short discussion of
evolutionary principles in relation to the sense-organs.

The book is admirably got up; it is well illustrated,
many of the best illustrations being original; it should
find a place in the library of every university depart-
ment of zoology or physiology. J. GRAHAM KERR.

Pyramid and Prophecy.

The Great Pyramid, its Divine Message: an Original Co-ordination of Historical Documents and Archæological Evidences. By D. Davidson and H. Aldersmith. Vol. 1: Pyramid Records; a Narrative of new Discoveries concerning Civilisations and Origins. Pp. xxvii + 568 (70 plates). (London: Williams and Norgate, Ltd., 1924.) 25*s.* net.

THIS elaborate work is one of the assertionist class which has spread in recent years. The pyramid theories open with many pages on the reflecting surfaces of the Great Pyramid, fixing accurately the days of the solstices and equinoxes. Now such porous limestone cannot be polished to reflect, or even to glitter; and a diffuse faint glare at best, without any definite limit, would be entirely useless to define a given day in the year, as here asserted. Then we read of the shadow on a face being only exact once in a century, and approximately every fourth year. As at that time of year the change of declination of the sun, by the shift of 0·242 day, from year to year is under 6′—less than a fifth of the sun's diameter—the difference between one year and another would be imperceptible to the eye.

The theories here depend on the size of the pyramid base. This was really 9069 inches; the rock sockets into which the sides sloped down below the base vary from 9119 to 9131 apart, according to their depth. To attain the theoretical base of 9141 inches, ten inches is added to the longest side without any authority whatever. The actual diameters across the pyramid show 9069 inches, but it is asserted that the sides were curved so as to bring out the corners to the amount required by the theorists.

The historical treatment likewise depends on assertion. It is assumed that a year of 360 days was used concurrently with one of 365 days, and during long ages a cycle of 103 years resulted. This is highly improbable, and there is no proof of such a mixture. The cycle of 103 years is then used in various forms, though no such cycle is known; the calendar is asserted to have been revised and altered, but there is no proof of it. We read of "fictitious chronology of the Egyptians" and "Jewish chronological forgeries" when the records are not convenient.

A typical argument runs thus: Certain dated quarry marks are assumed to be on a fixed and not a rotating calendar; that throws the quarrying into the hot season; then that proves quarrying to have been done in the hot season; and that proves that a fixed calendar was used—exactly the assertion made to begin with. The years recorded in Egyptian history are asserted to have been copied from the dimensions of the Great Pyramid in inches, though it is said that "the compilers of the kings lists added the measurements of radii to the measurements of arcs, horizontal to vertical distances, and totalled measurements in cubits together with measurements in inches." Such is what the authors have to do to produce their coincidences. All of this is introductory to the prophetic detail of the passages of the pyramid (including the exact length of the recent War), Christian chronology, and innumerable vexed questions, which are all solved by asserted connexions. It is sad to see such labour and expensive publication devoted to confusing the public mind.

Ores as Igneous Rocks.

The Ore Magmas: a Series of Essays on Ore Deposition. By J. E. Spurr. Vol. 1. Pp. x+430. Vol. 2. Pp. ix + 431-915. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 2 vols., 40*s*.

THESE two interesting and suggestive volumes consist of essays on ore deposits based on Mr. J. E. Spurr's varied personal experience of American mines, which include so many types that they illustrate the chief phenomena of ore formation. Mr. Spurr shows in this work the clearness of insight, caution, and scientific ability which have made his contributions to economic geology of special value. He was one of the pioneers of the school which attaches predominant importance to igneous action in the formation of ores. He emphatically rejects lateral secretion or the formation of ores by surface waters, and also by the agency of deep-seated hot springs, as no water circulation could explain such facts as the enormous concentration of copper ores in Arizona. He insists, moreover, that ores have been made by processes that do not operate in any accessible zone of the crust, as he has not seen in the deepest mine visited any lode in process of growth.

Mr. Spurr early adopted the view, from his work in Alaska, that there is no sharp line of division between mineral veins and igneous dykes. His "alaskite," a name now generally adopted in geology for a group of quartz-alkali-felspar dyke rocks, he regards as passing imperceptibly to arizonite, or quartz veins formed as the most acid differentiation product. He calls such intermediate types vein-dykes. He unfortunately has not seen the memoir by Belt, who in 1861 advocated the igneous origin of many Australian quartz v Mr. Spurr knows that work only by the reference to Belt's "Nicaragua"; he quotes A. W. Howitt, howe who temporarily adopted Belt's hypothesis, but to wrong turning when he abandoned it and becan lateral secretionist. The origin of the injection of vein-dykes Spurr attributes, not to crustal pressure to some force inherent in the material, which he sugg is gas pressure. This force is sufficiently powerfu tear ruptures many miles in length through rocks, as evidence is clear that many ore veins did not e pre-existing fissures. He attributes the ultimate or and distribution of the chief ore deposits to the eff of magmatic migration during sub-crustal flow. recognises three types of movements: the horizo pressure around the uprisen molten masses prod overfolds and overthrusts; the blocks above an in sion are uplifted by "injection faults"; and the do sagging of the areas undermined by sub-crustal produces "adjustment faults." In connexion with intrusion of igneous rocks he discusses Daly's the that the great plutonic masses have worked their upward by overhand stoping, and also the expla tion previously adopted that some igneous rocks h replaced an equal bulk of sediment by assimilat He rejects both explanations, as in his experience field evidence gives no adequate corroboration either. The two last chapters deal with inject breccias, and ore-chimneys, which he refers to exc tional earth movements also due to igneous intrusi

Some geologists may think that the author attribu too great a rôle to igneous activity, as that theor inapplicable to some types of ore deposits; but for m of the most important ores the author's conclusi appear sound, if it be understood that his conceptio magmatic action lays stress on magmatic waters and on simple fusion. Many of the author's conclusi have a bearing on wider problems than those of pr able mining. The fore-deeps of the Pacific the aut attributes to down-sagging around the uplifted c tinental blocks, and he remarks the similarity Kainozoic volcanic activity and ore formation around the Pacific. This view attributes the exist Pacific basin as a whole to Kainozoic movement, and author remarks that we are still living in the "Terti catastrophic period." The widespread crustal distu ances are also shown by long fissures which have b proved by mining to cut across the country independ of the mountain folds. They are therefore due to fault movements that followed the last great epoch mountain folding.

Mr. Spurr's work illustrates the important li thrown by mining geology on the structure and physical geography of the earth's crust. J. W. G

Our Bookshelf.

The Calculation and Measurement of Inductance and Capacity. By W. H. Nottage. Second edition. Pp. xi+224. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1924.) 7*s.* 6*d.*

MANY problems in connexion with obtaining formulæ for the inductance and capacity of various conductors and systems of conductors have recently been solved. As these solutions have usually been given in papers contributed to learned societies in various countries, it is a convenience to have them collected together in a single volume. As a rule the formulæ are very lengthy and laborious to calculate, and hence we think that more references should have been given, as in some cases the limitations of the formulæ have not been stated. We were surprised that no formula is given for the inductance of a concentric main. It is true that in most cases with low frequency it can be neglected, but in radio work it is often of importance. On p. 65 a formula is given for the *average* potential of a single straight wire. We quite fail to understand what this means, as, being a conductor, it is presumably at the same potential throughout.

We were interested to see how rough calculations on empirical formulæ gave results which agree closely with the measured values. As in the measured values the resistivity of the earth has to be taken into account, it looks as if—at least on dry days—this resistivity can be taken as constant. Numerous methods of measuring capacity and inductance are given, but it would be a help if it were pointed out which are the most suitable for special cases. Descriptions are also given of the numerous appliances that are used for making these measurements. It is surprising that in a second edition Kirchhoff's name is persistently spelt with one *h*.

Trattato di chimica generale ed applicata all' industria. Per Prof. Dott. Ettore Molinari. Vol. 1. *Chimica inorganica.* Parte prima. Quinta edizione riveduta ed ampliata. Pp. xv+680. (Milano: Ulrico Hoepli 1924.) 40 lire.

THE number of books dealing with the whole range of industries to which the description chemical is applicable is very small, and among these Molinari's work, fashioned on a new and original plan, has come to occupy a very definite and important place. The measure of its success may be gauged from the appearance, within the space of less than twenty years, of four editions in Italian, each in turn rapidly exhausted, two in English, two in Spanish, and one in French. The present volume, which begins the fifth Italian edition, contains more than 200 pages devoted to the elementary exposition of general principles, this section having undergone considerable expansion at the hands of the author's son, Vittorio. It treats likewise of hydrogen, the halogens, the elements of the oxygen group (also air and its rare constituents), nitrogen and phosphorus, etc. The very full trade statistics and other special features of the work are retained, but various subjects, such as hydrogen, sulphuric acid, and the utilisation of atmospheric nitrogen for the manufacture of synthetic ammonia, etc., are treated at greater length than formerly. The footnotes, possibly too copious in some cases, remain, and diagrams and figures are interspersed even more lavishly than in the preceding edition; the printer's work is all that could be desired. The second part of the volume on inorganic chemistry is promised before the end of the current year, and will be followed by a new issue of the companion volume on organic chemistry.

The Mongol in our Midst: a Study of Man and his Three Faces. By Dr. F. G. Crookshank. Pp. 128+29 plates. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1924.) 2*s.* 6*d.* net.

DR. CROOKSHANK argues with much skill in favour of his view that in the not uncommon occurrence of Mongoloid characters in Western Europeans, of which the extreme example is the so-called Mongoloid imbecile, there is something more than a fortuitous resemblance to the racial Mongol. He adduces a large number of homologies between these abnormal cases and the Mongol races, emphasising in particular the peculiar method of sitting with the legs in the horizontal position familiar in the statues of Buddha, which seems natural to the Mongoloid imbecile, and maintains that they point to the atavistic character of this peculiarity. Mr. H. Peake has argued in favour of the introduction of a Mongoloid strain in Northern Europe in prehistoric times, and it is by no means impossible that some infiltration of Mongol blood may have followed from the racial invasions of Eastern Europe. Dr. Crookshank, however, presses his theory further and seeks to connect the Mongols with the orang, setting them against the group in which he places other races—with dementia præcox as the corresponding form of mental disease—and the chimpanzee and gorilla. It is this part of his theory which has been most strongly criticised, for, as he shows, it involved the adoption of Klaatsch's theory of two distinct parent types, one for orang and Mongols on one hand, and one for gorilla and negro on the other—a theory which has not found favour among anthropologists generally.

Transactions of the Institution of Chemical Engineers. Vol. 1, 1923. Pp. xv+120. (London: Institution of Chemical Engineers, Abbey House, Westminster, 1924.) n.p.

THE Institution of Chemical Engineers is to be congratulated on its first volume of Transactions, which reaches a high standard both in form and in contents. The volume opens with a brief history of the steps taken to found the Institution, and contains papers read before it. The first paper is a long monograph by T. C. Finlayson on industrial oxygen. In this the various known methods for the manufacture of oxygen are described and analysed both from the technical and economic aspects, and an account of original experiments is given. The results obtained were not capable of industrial application, but the paper was described as valuable in the discussion. A short contribution on absorption towers by M. B. Donald and C. W. Tyson, a study of the conditions of constant rate of flow in filter presses by M. B. Donald and R. D. Hunnemann, an outline of the present knowledge of corrosion by M. B. Donald, and a bibliography of chemical engineering literature (1900–1923) form the rest of the volume. It is evident that these contributions have been

composed in a scientific and practical style, and the volume is evidence of the really good work which the Institution may be expected to do in future in the interests of chemical engineering.

Physische Meereskunde. Von Prof. Dr. Gerhard Schott. (Sammlung Göschen Nr. 112.) Dritte, umgearbeitete Auflage. Pp. 155. (Berlin und Leipzig: Walter de Gruyter und Co., 1924.) 1.25 gold marks.

THIS is a very small book. but the amount of information that it contains is extraordinarily great. The author does not discuss the whole subject from a general point of view so much as give a concise exposition of each section of physical oceanography, together with the methods employed in obtaining the data.

The book is divided into three sections. The first deals with the ocean as a whole; the depth and character of the sea-bottom are discussed, and its general morphology in relation to the land is described. Section 2 deals with the properties of sea-water, and is divided into subsections on the physics and chemistry of sea-water, on the distribution of temperature in the sea, and on the ice found in the sea. The last section describes the various kinds of movement occurring in sea-water. The theory of wave motion in the sea is discussed in a very interesting manner. The last two chapters on the tides and on the ocean currents are rather disjointed, because the facts are first set out by themselves and their explanation is given afterwards in the form of explanatory paragraphs.

Organic Syntheses: an Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Vol. 3. H. T. Clarke, Editor-in-Chief. Pp. v+104. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 7*s.* 6*d.* net.

VOL. 3 of this series fully attains the high standard reached in the two previous volumes. The preparations described are models of careful work and explicit detail. For the use of students the book is excellent, though the quantities employed in the preparations are somewhat large, and changes in these quantities sometimes imply considerable alteration in the other experimental details, as the reviewer found in the preparation of allyl alcohol (vol. 1, 15-19).

The chief purpose of the series is to place on record certain well-tried and proven methods of preparing intermediate compounds used in research and technical work, and the volumes so far produced justify the work of the contributors. It seems a pity that more contributors have not added to these volumes some of the many methods of preparing products necessary for the prosecution of research which have been improved in their laboratories but are not generally known.

The method of indexing is novel and should prove useful. L. C. N.

Amurath to Amurath. By Gertrude Lowthian Bell. Second edition. Pp. xvii+370+105 plates. (London: Macmillan and Co., Ltd., 1924.) 21*s.* net.

A SECOND edition of Miss Bell's account of her journey from Aleppo to Baghdad, and thence to Konia, is very welcome; for surely "Amurath to Amurath" deserves to rank with the best of travel books. Bell's keen observation, penetrating judgment, profound archæological knowledge, which are comb with a gift of graphic narrative, are here perhap their best. She is equally at home in describing ancient Mesopotamian site and in recording the go of the bazaar. Her thumb-nail sketches of the pe she met are vivid and compact with an imagina insight into the soul of the Eastern races. As book was first published in 1911, soon after the rising of the Committee of Union and Progress and advent to power of the young Turk, its polit interest, when read in the light of subsequent eve scarcely need be emphasised.

A Handbook of Telephone Circuit Diagrams: Explanations. By John M. Heath. Pp. x+ (London: McGraw-Hill Publishing Co., Ltd., 19 12*s.* 6*d.* net.

To any one who desires to acquire a good pract knowledge of the art of telephony we can recomm this book. In order to get the full benefit from however, he should first study a good element treatise on the subject. Every telephonist has spend much time and study in puzzling out the vari wiring diagrams of the different units in a teleph system. In this book the circuit diagrams are predominating feature. They are arranged in a logi and progressive manner, following generally the histori development of the art. Having once understood diagrams of the component parts, it is easy to und stand the wiring diagrams as a whole. The symbols well chosen and a study of the circuit diagrams will g the necessary complementary knowledge to that giv in text-books.

Evolution, Knowledge and Revelation: Being Hulsean Lectures delivered before the University Cambridge, 1923–24. By the Rev. Stewart McDowall. Pp. xviii+118. (Cambridge: At t University Press, 1924.) 6*s.* net.

THOUGH dealing with problems of religion and phi sophy, and leaning entirely to an extreme form metaphysical idealism, this little book, consisting four lectures, is thoroughly scientific in spirit and method. The lectures aim, the author tells us, establishing a theory of knowledge based on the fac of evolution and in sympathy with the spiritual int pretation of Nature by the best metaphysical systen Though necessarily slight, the book is never dull.

Economic Geography. By Prof. R. H. Whitbeck a Prof. V. C. Finch. Pp. x+558. (London: McGra Hill Publishing Co., Ltd., 1924.) 17*s.* 6*d.* net.

PROFS. WHITBECK and FINCH'S volume is a well-writt text-book on orthodox lines, which result in the field economic geography being somewhat restricted. T United States and Canada are treated very fully as o economic unit, followed by a summary of Canad These chapters contain much useful material, but t rest of the world, with the exception of Central a South America, receives too brief a treatment for t book to prove acceptable on the eastern side of t Atlantic. The sketch maps and diagrams are i structive, and there are bibliographical references.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

International Co-operation in Phenological Research.

THE need for international co-operation in recording the dates of special events in the seasonal development of a few representative species or varieties of native and established cultivated plants will be recognised when the facts are considered, that the time of such events as the opening of leaf and flower buds, the completion of growth, the ripening of fruit, the harvesting of crops, etc., are true expressions, not only of the influence represented by the three important elements of climate, temperature, precipitation and sunshine, but, in addition, that represented by all other elements in the physiographic complex of the environment affecting in any degree the seasonal development of a plant. When it is considered, further, that the correct interpretation of the geographic and economic significance of the average date of the same event, at representative places within the geographic range of the species, is an element of a true index to the bioclimatic character of each place and the immediate region represented, it will be realised that such records are of the greatest importance, especially in connexion with those of temperature and precipitation, in the study of geographic distribution of plants and animals, types of climate, cultivated plants, world agriculture, etc.

While the influence of climate and weather conditions upon native plants and cultivated crops have been noted from the earliest days by individual observers, it is only in the last fifty years that attempts at united efforts, such as with the records of temperature, or pressure, and, above all, rainfall, were sufficiently organised anywhere to form the branch of science designated as "phenology."

Yet its importance to agriculture and horticulture is great and has already proved to be of material commercial value. This is especially the case in the United States through the Department of Agriculture, where it has received great attention under the leadership of Dr. A. D. Hopkins. The same is true, if to a less recognised extent, in the British Isles, Central Europe, Belgium and Holland (under Dr. Ross), the other countries actively carrying on similar work. In Germany, under Hofman and Ihne, it has been carried on unofficially for more than forty years on one systematic plan confined to flowering plants, especially trees and shrubs.

British co-ordination began in 1877 under two distinct organisations. The smaller was carried on in the *Natural History Journal* from 1877 to 1898, as "Floral Calendar" and "Migrant Table," twenty year averages being obtained. But more important and permanent is the phenological work under the auspices of the Royal Meteorological Society, under the successive leaderships of Rev. T. A. Preston, Mr. Edward Mawley (by whom it was reorganised in 1890), Messrs. Clark and Adames, and the present committee. Flowers, birds, and insects are included in the records, but fourteen of the first form the most essential part.

The results of this work as represented by averages of the essential records have been correlated with the averages of the three most effective climatic elements, temperature, rainfall and sunshine, and thus form a comprehensive interpretation of the various climatic regions and areas of the British Isles and their relation and relative importance to our agriculture and horticulture. They also lend themselves to important geographical correlation with the countries named above, and, not least, with the exhaustive work in the United States. We therefore venture to suggest that the time has come for similar systematic work to become world-wide.

Special mention must be made of the Hopkins' "Bioclimatic Law," worked out for the United States, but through which results obtained in one country can be applied elsewhere, with considerable confidence, if equivalent phenological records are available.

It is for such reasons that the present appeal is made, for co-operation in the establishment of similar work through the Dominions and elsewhere, especially throughout Europe and extra-tropical Asia,[1] whereby accurate records may accumulate as a basis for interpreting the relative influence of the local and regional climate, weather, and seasons on the periodical events in plants and animals, seedtime, and harvest, etc. Our suggestion is that such world-wide inauguration of this work, particularly in extra-tropical countries, will quickly provide data of great scientific and economic value towards the advancement of world agriculture. After the lapse of ten years or so, sufficient data should exist for inter-regional correlation, whereby, under the Bioclimatic Law referred to above, results obtained from similar records elsewhere could be given universal application.

Such correlation is yet in its infancy, but has already been tentatively extended from the United States to Great Britain[2] and Western Europe, although hampered by the divergent character of the records in different countries.

This suggests that, in further development, a more uniform and simplified method is most desirable, including at first a very limited number of common and widely distributed species or varieties[3] of native or cultivated plants and only the more essential events.

Our own method of working is based upon a schedule sent out each year to the observers. No two countries can use identical lists, and each country or province would need its separate organisation. But in selecting the series best covering for the given region the full period of growth and maturity, the inclusion of some identical flowers of widespread range would have great value for such possible correlation. The British list suggests a selection of some of the following as possible for common ground: hazel, dog-rose, snowdrop, blackthorn, horse-chestnut, oxeye daisy, and hawthorn. It may prove desirable to add a few more of widespread range to the lists now in use, such as the first shooting and first unfolding of the basal pinnæ of bracken, flowering of almond or peach, silver birch, locust tree (white acacia): possibly the flowering of some field crop and weeds of cultivation. Suggestions as to any such adapted for observation in other areas would be helpful.

It occurs to us that as a beginning some one official or investigator at each of the more representative meteorological and agricultural stations and other institutions of public service in scientific research, as well as private workers, in each of the principal countries might be specially interested in making consecutive observations. It would require little time and effort to record the dates of the more

[1] Tropical regions present far more complicated problems, yet it seems a pity to exclude them.
[2] Journal of the Washington Academy of Science, 1921, pp. 223-227.
[3] With varieties, the same must be selected for all stations.

important seasonal events of some common plant or plants, such as the opening of the leaf and flower buds on a tree or shrub, observed from the office window, the ripening and harvesting of a crop in an experimental plot or on neighbouring farms, yet such records would serve not only as a matter of personal interest but also, through an interchange of records each season, and ultimately the publication of averages, they would soon furnish a source of information which would be of inestimable value to investigators of the problems of local and world agriculture.

1925 completes the thirty-five years of observations on one system in the British Isles, a period well recognised as of meteorological importance, and with its close it may be advisable to introduce modifications. Therefore we are the more anxious to associate ourselves with any wider developments which may be evolved, and we make an earnest appeal for such co-operation.

The interest manifested by replies to these suggestions from persons in different countries will indicate whether or not further efforts towards the formulation of a uniform plan of records and co-operation will be justified. We ask such to communicate with us.

Copies of our last Report illustrating the work carried on in Great Britain will gladly be sent to indicate its character. Moreover, many readers of NATURE in this country[4] will know individuals and societies whom it would be well to approach, and the names and addresses of such will be most welcome. No doubt there are many solitary workers unaware of what is being done, for, as Dr. Bos has pointed out, no journal of phenology at present exists. The help also of residents in the homeland would be most welcome.

The fact that the work in the British Isles has been under the auspices of the Royal Meteorological Society is to a certain extent accidental. For it concerns a far wider circle than meteorology, particularly botanical, agricultural, ecological, biological, climatic, and geographical interests. For this reason we are acting after consultation with, and approval of, not only the well-known phenologists already named, but also Mr. J. C. F. Fryer, of the Biological Department of the Ministry of Agriculture and Fisheries; Mr. J. Burtt Davy, lately Chief of the Division of Botany and Government Botanist, Union of South Africa; Mr. A. G. Tansley, Prof. E. J. Salisbury and Prof. F. W. Oliver, through whom we have the support of the Ecological Society. We have also the full approval of the Council of our own Society through Capt. C. J. P. Cave, our president, and Mr. R. H. Hooker, a recent president.

Communications may be addressed to J. E. Clark, 41 Downscourt Road, Purley, Surrey, England.

J. EDMUND CLARK,
IVAN D. MARGARY,
RICHARD MARSHALL,
Phenological Committee of the Royal Meteorological Society.

NOTES ON THE BIOCLIMATIC LAW.

THE writer has had the privilege of seeing the original draft of Mr. Clark's letter to NATURE with reference to "international co-operation in phenological observations," and he is heartily in sympathy with the ideas covered in this initial movement towards the extension of the service to world interests in agriculture through observations and research in this relatively unrecognised branch of natural scienc

In further reference to the Bioclimatic Law me tioned by Mr. Clark, it may be stated that it w from studies of the relation of latitude and altitu to the difference in time of the emergence of t Hessian Fly, and its attack on wheat sown at giv times, that the idea of a natural law was suggest in 1895, and that the development of this law h been based largely on a comprehensive study of t dates of seeding and harvesting winter wheat with the distribution of this crop in the United States on general and specific and phenological observatio and studies in this country, and utilisation of t published records of the comprehensive work in t British Isles and Germany. On account of the meag or lack of phenological records from other countrie it has been necessary to rely on published climati biological, geographical, and agricultural data for t inclusion of most of the other countries of the wor in a comprehensive study of the relations of the la to world agriculture and other human interests.

While these additional data have served as im portant elements in the development of the law an its application to research and practice, it is in creasingly apparent that phenological data from th different countries are far more important.

Briefly stated, the Bioclimatic Law is one of effect i response to the laws of causation represented by th sun, the motion of the earth, unequal distributio of land and water, and the varying physiographi features of the continental and insular areas. Th law of effect is interpreted as requiring a broa general, country-wide variation in time and tem perature, as related to types of equal phenomena c life and climate, at a unit constant rate per distanc in degrees of latitude, poleward and equatorward longitude, east and west; and feet or metres of alt tude above sea-level (as four days of time betwee the dates of the same phenological event to on degree of latitude, five degrees of longitude (earlie from west to east), and four hundred feet of altitude).

The application of these principles in the study o the geography of life and climate, designated as th science of *Bioclimatics*, is in accordance with th principle of the *variable* and the *constant*, in whic the recorded quantity in time, temperature, etc., fo a given geographic position is the *variable*, and th corresponding quantity computed for the same posi tion from the unit constant requirements of the law is the *constant*.

The variation of the recorded quantity from it constant represents a *Bioclimatic Index*, or measure of the intensity of the local and regional influences o the causation complex relative to that determine for a continental or intercontinental base. Thus th bioclimatic index for a number of representative positions within a local or general region will indicate the trend and extent of the variations from the requirement of the law and consequently serve, in connexion with information on the topography and precipitation, as a basis for interpreting the bio-climatic character of the region, as to the type of climate and corresponding life that may be expected to prevail; in other words, indicate the life and climate, or bioclimatic zone, that is represented, which in turn will indicate the kinds of crops that can or cannot be grown, so far as controlled by tem-perature and precipitation.

Thus if we had, in addition to the already available meteorological data, a long-time series of pheno-logical records from representative positions in the

[4] Incidentally, we would point out that fresh British observers are always welcome. Our appeal through the pages of NATURE two years ago gave us a most satisfactory accession of stations.

[1] Suppl. No. 9, *Mon. Weather Rev.*, U.S. Dept. Agric. Weather Bureau 1918.

different countries of the world, their bioclimatic zones could be predicted and mapped (so far as maps of topographic surveys are available), as has been demonstrated by a detail map of the bioclimatic zones of the United States and preliminary maps of the thermal zones of the British Isles, Germany, and Australia. A. D. HOPKINS.

Organisation in Chemical Societies.

As one who has some direct knowledge of the affairs of the Chemical Society, I should like to reply to the letter from Dr. M. W. Travers which appeared in NATURE of October 4. Dr. Travers has presented a singularly one-sided statement of the position, for in his endeavour to prove that the societies give an inadequate return for the subscriptions received, he omits essential points which any fair-minded man would take into consideration before giving a verdict on that charge.

In the first place, Dr. Travers criticises adversely the decision to make an extra charge for the Chemical Society's "Annual Reports," since, in his view, students, to whom this publication particularly appeals, will be thereby discouraged from joining the Society. He omits to mention, what is equally relevant, that, for the present, new fellows are not required to pay the entrance fee of 3*l*.—a financial alleviation which has been introduced mainly to meet the case of the young chemist, and ought in fairness to be set against the new charge for the "Annual Reports." The necessity of paying 3*l*. in addition to the first annual subscription has, quite naturally, prevented many students and junior chemists from joining the Society.

When the Chemical Society's Library, with the unique and development of which all the leading chemical organisations are now associated, is put on record by Dr. Travers, because it is not "in any way comparable with the Patent Office Library." Against this unwarranted and contemptuous reference to the Library of the Chemical Society I should like to put the plain fact that, since the opportunities for using the Library were extended some years ago, the annual number of readers has increased from between two and three thousand to between six and seven thousand, and is rising steadily. Further, the Patent Office Library, however useful to Londoners, cannot serve chemists who reside in the provinces, whereas a large proportion of the books and journals in the Chemical Society Library can be borrowed, either directly or through the post. The extent of the availability of the Chemical Society Library is not generally realised.

As to abstracts, it is, of course, well known that the American publication covers a much wider area than the two sections of the British abstracts combined, but that is not necessarily an unmixed advantage. Against the narrower scope of the British publications, however, it is only right to set the fact that abstracts appear there more promptly than in *Chemical Abstracts*. Some papers, more particularly those from American sources, are reported earlier in *Chemical Abstracts*, but the majority are abstracted first in the British publications. The more prompt appearance of the British abstracts is a valuable feature which deserves to be emphasised.

Those who give time and thought to the affairs of the chemical societies have, I believe, no objection to candid criticism, provided it is just. In connexion with abstracts, for example, the desirability of improvement and co-ordination is recognised, and I would invite Dr. Travers (and any other critics) to submit to us any really *constructive* suggestions, not in the spirit of his letter, but in the spirit of co-operation. As chairman of the Bureau of Abstracts, I guarantee that any such practical suggestions will receive fair consideration. JAMES C. PHILIP.

Imperial College of Science and Technology,
London, S.W.7.

Transformations of Elements.

THE theory of allotropy, starting from the supposition that every state of aggregation (phase) of a so-called simple substance (system of one component) is complex, that is, consists of different molecular species, and stating that behaviour as a simple substance is only due to the rapid establishment of equilibrium between these different kinds of molecules (inner equilibrium), has led, when applied to metals, to a theory of electromotive equilibrium. Herein it is assumed that with metals the complexity consists in the existence of atoms, ions (of the same or of different valency) and electrons. These various particles give rise to an inner equilibrium which in the simplest case is represented by the formula:

$$M_s \rightleftarrows M_s^{\nu\cdot} + \nu\Theta_s,$$

in which ν indicates the number of positive charges on the metal ion, and the suffix s that the solid state is being considered.

From this point of view, polarisation occurs if the withdrawal of electrons and the combined ejection of ions, respectively the supply of electrons and the combined deposition of ions, takes place more rapidly than the establishment of the inner equilibrium. If there is no formation of molecules, this can only be due to a too slow course of the reaction mentioned above.[1] By sending a metal rapidly into solution, for example, by means of an electric current, according to these considerations the metallic surface will become impoverished as regards electrons and ions, and the theory shows that in this case the metal will behave electrolytically as a more noble metal, which normally contains a smaller electron- and ion-concentration. Consequently, a base metal temporary can transform superficially into a pseudo-noble state by rapid anodic solution.

Now the question arose if experiments in the same direction, but arranged differently, could possibly lead to wider and deeper disturbances. In connexion with secondary phenomena, such as the discharge of anions, contact with an electrolyte is an important hindrance to creating a powerful disturbance. This difficulty is removed, of course, if, instead of a liquid, a rarefied inactive gas is used. That also, in inactive gases, metals show polarisation phenomena, is found by Gaede and others, but while by their point discharges only small current densities were acting, the disturbance could not be large. It is clear that the best method to obtain a large disturbance is to use the electric arc-flame. For several years I have therefore intended to study different metals, in a vacuum lamp, in the hope that on increasing the current density the disturbance of the metal would become so large, that not only the valency electrons, on leaving their orbits, should be snatched away and thus prevented from falling back, but also the deeper electrons, and perhaps those of the nuclei, whereby, in the latter case, also α-particles could be split off.

Much occupied by other investigations, the experiments mentioned above were delayed. I was greatly interested, therefore, to read, in July last, the communication of Prof. Miethe on the transformation of mercury

[1] See "The Theory of Allotropy," p. 130.

into gold in the mercury lamp of Jaenicke, when burning overcharged. I resolved to return to my proposed experiment, and I did not intend to study mercury but lead. In accordance with this original scheme, I have now carried out some experiments. Peculiar difficulties arise, because lead fuses at 327° C., and also because lead, solidified in a quartz vessel, breaks the vessel if heated again. Notwithstanding this, we succeeded in constructing a satisfactory lead quartz lamp (Fig. 1). The two legs A and B end in two narrow tubes, in which two steel electrodes are cemented with sealing wax. Around these cemented ends two little copper water coolers G and H are inserted, preventing fusion of the sealing wax. Vessel C is the store vessel, into which the pure liquid lead is poured, after which the open end is sealed off. An electric furnace around C keeps the lead liquid. Tube D, which is bent, contains a capillary F and ends in a cock K. The free end of the cock is connected with the mercury diffusion pump.

When a high vacuum is reached, the vessel C containing the lead is heated to redness with the Bunsen burner, with the result that all oxide is dissociated, and that

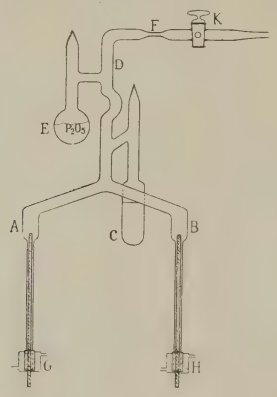

FIG. 1.

the metal, freed from all gases, has a surface as smooth as pure mercury. After closing the cock K and breaking the connexion with the pump, the apparatus is inclined, and the liquid lead is run into the two legs of the lamp. Now the lead is once more heated to redness in the two legs to drive out the gases from the steel electrodes. Many gas bubbles escape now and the apparatus is evacuated once more. After that the lamp is ready, and can be used in the same way as the mercury lamp, with this difference only, that removable radiating coolers cannot be placed around the legs A and B before the lamp is working. At the end, the liquid lead is again brought into the vessel C, which is continuously heated by the little electric furnace at 350°.

Because bismuth is also an element which is to be considered here, and the system lead and bismuth has a eutectic point at about 120°, it was of interest also to try this eutectic composition. We found that this alloy can be used in exactly the same way.

It is clear that the investigation of these lamps is not only of use to show whether transformations of elements can be realised, but also to study the arc spectrum. The lamp here described, like the vacuum mercury lamp, burns at relative low voltage; we are constructing another lead lamp which, like Jaenicke's lamp, burns at higher voltage. We hope to be able to communicate some results shortly.

A. SMITS.

Laboratory of General and Inorganic Chemistry,
University of Amsterdam, September 15.

An Approximation to the Probability Integral.

THE probability integral

$$\Theta(t)=\frac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt$$

can be represented by the simple approximation

$$\frac{6}{\sqrt{\pi}}\cdot\frac{t}{3+t^2}=3\cdot385\frac{t}{3+t^2}=1\tfrac{1}{8}\frac{t}{1+\frac{1}{3}t^2}$$

over such a range ($t<\sqrt{3}$) as to make the approximation useful to the statistician and others whose problems do not require great accuracy.

Since

$$\Theta(t)=\frac{2}{\sqrt{\pi}}\left(t-\frac{t^3}{3}+\frac{t^5}{10}-\frac{t^7}{42}+\ldots\right),$$

and ($t<\sqrt{3}$)

$$\frac{6}{\sqrt{\pi}}\cdot\frac{t}{3+t^2}=\frac{2}{\sqrt{\pi}}\left(t-\frac{t^3}{3}+\frac{t^5}{9}-\frac{t^7}{27}+\ldots\right),$$

$$\Theta(t)=\frac{6}{\sqrt{\pi}}\cdot\frac{t}{3+t^2}-\frac{2}{\sqrt{\pi}}\left(\frac{t^5}{90}-\frac{5t^7}{378}+\ldots\right).$$

For small values of t the approximation is evidently good. Beyond $t=\sqrt{3}$ it clearly fails. But at $t=\sqrt{3}$ the error is within one per cent. At first the approximation is slightly in excess of the function, but the error reaches its maximum near $t=1\cdot2$, vanishes after $t=1\cdot5$, and then becomes negative. As $t=\sqrt{3}$ means more than 3·6 times the probable error, the range of useful approximation is quite considerable.

For some purposes it will be convenient to write

$$t=\sqrt{3}\tan\tfrac{1}{2}\phi,\quad \phi<90°,$$

$$\Theta(t)=\sqrt{\frac{3}{\pi}}\sin\phi=[-0\cdot0100]\sin\phi.$$

Thus for $\Theta(t)=\frac{1}{2}$, $\phi=30°\cdot77$ and $t=0\cdot4766\ldots$ as compared with the true value $\rho=0\cdot4769\ldots$ Further comparison is given in the following table:

ϕ.	t.	t/ρ.	$\sqrt{\frac{3}{\pi}}\sin\phi$.	$\Theta(t)$.	Diff.
60°	1·000	2·097	0·8463	0·8427	+0·0036
69·8	1·208	2·533	0·9171	0·9125	+0·0046
83·1	1·535	3·219	0·9701	0·9701	0·0000
90	1·732	3·632	0·9772	0·9857	−0·0085

Beyond the last point the approximation allows for 23 cases per 1000, while the normal law allows 14. As abnormally large deviations are often in excess of expectation, this is no bad thing. For approximate calculations of this kind it is well to remember that the reciprocal of 2·1 is 0·4762, which is very nearly the value of ρ.

It is evident that

$$\int_0^t\Theta(t)dt=\frac{3}{\sqrt{\pi}}\log_e(1+\tfrac{1}{3}t^2)$$
$$=3\cdot897\log_{10}(1+\tfrac{1}{3}t^2)$$

is a very close approximation over the range $0<t<\sqrt{3}$.

A far closer approximation to the error function has been given by Mr. H. B. C. Darling (*Quart. J. of Math.* xlix. p. 36), but its form makes it unsuitable for the purely practical purposes here contemplated.

H. C. PLUMMER.

Artillery College, Woolwich, S.E.18,
October 1.

Is *Orchis Fuchsii* (Druce) a Valid Species of Orchidaceæ?

THERE has for some time been going on a controversy among botanists as to whether Linnæus in establishing his species *Orchis maculata* omitted from, or intended to include within, it a very closely related form collected by himself, which has been raised to specific rank by Dr. Claridge Druce as *O. Fuchsii*. The question whether the latter is only a variant of

the former or not appears to depend on whether Linæus in his diagnosis of *maculata* intended the description of the middle lobe of its trifid labellum to apply to one or both.

In reading the discussion, I was reminded of some observations—of interest perhaps to the disputants—which I made on this orchid in 1922 during a stay at Heathfield in Sussex. The banks of the railway between Mayfield and Heathfield, and of the high road from Brighton through the latter place to Kent, are profusely empurpled in its season with the spotted orchis. Long habit induces me, whenever in the country, to gather specimens of the flowering plants I meet with, for the pastime of discovering any variation from type, especially of orchids, to record the proportion of cross to non-fertilised flowers. I had brought to my rooms, therefore, handfuls of the orchid.

While on the majority of the plants, gathered from the *same* communities—all to me obviously *maculata*—the lateral segments of the labellum were normal in being larger than the central one, which, though somewhat less in breadth, did not much, if any, exceed it in length, I was nonplussed—as notes and a rough sketch made in my journal at the time indicate—to find in a considerable number that the central lobe of the florets, differing from the figure in Fitch's illustrations (the only botanical work I had with me), was conspicuously longer, very sharp pointed, and, both actually and in comparison with its fellow side-lobes, much narrower than in the others. I believe (without being absolutely certain on the point) that florets with the more normal labellum and those with a long-pointed mid-labellar lobe occurred together on the same spike. As I was then unaware of the controversy I did not make the precise observations I might have done, thinking that the differences were—as I incline still, even if they occur on separate plants only, to believe—merely varietal. *O. Fuchsii* would, in my amateur opinion, appear to be only a variety (not an oft-recurring sport) of *O. maculata*.

HENRY O. FORBES.

Deanway, Beaconsfield, Bucks.

Regularities in the Spectrum of Ionised Titanium.

THE spectrum of ionised titanium is very interesting, owing to the fact that a large number of chief lines lie between $\lambda = 3000$ and $\lambda = 4500$, and hence enhanced lines of titanium form a very characteristic feature of the spectrum of the solar chromosphere and the stars. As regards the chromospheric spectrum, lines of Ti^+ at $\lambda = 3685$, 3759, 3761 reach a height of 6000 km., and many other lines reach heights exceeding 1500 km., while resonance lines of titanium (=5193·12, 5173·92, 5210·59)—following the classification given by Kiess and Kiess—reach heights of 50 km. only. In this respect the behaviour of titanium is parallel to that of calcium, both as regards the ordinary as well as the enhanced lines, though owing to the larger atomic weight, titanium fails to reach the great height of Ca^+, as given by the H and K lines. Also no lines of Ti^+ dominate the spectrum to the same extent as the H and K lines dominate the spectrum of Ca^+.

Recently King has published a very thorough study of the spectrum of titanium in the furnace, and the arc. This has enabled me to study the regularities in the spectrum of Ti^+. The chief lines can be arranged as quartet groups, and the lowest levels are given by three p-terms with the frequency differences 81 and 509. The structure fits in admirably with the rules given by Lande (*Zeitschrift für Physik*, vol. 1); for, according to the displacement rule of Sommerfeld and Kossell, the spectrum of Ti^+ ought to be similar to that of scandium, which has been shown by Catalán to consist of quartets and doublets. The separation of the p-terms, according to Lande, ought to be as 5 : 3, while 860 : 509 = 5 : 2·96. The separations of the d-terms ought to be as 7 : 5 : 3, while we have found them to be 98·40 : 69·46, 45·86 = 7 : 5 : 3·1. The precise value of the ionisation potential of Ti^+ has not yet been obtained, but it seems to be about 13 volts. The ionisation potential of titanium itself has been shown by Kiess to be about 6·8 volts. This is in accordance with the fact that in the spectrum of stars the behaviour of T^+ and Ca^+ are almost parallel—*vide* W. J. S. Lockyer, Mon. Not. Roy. Ast. Soc., vol. 81, who finds that titanium lines are stronger in F5G stars (ϕ-Cassiopeia) than in A2F stars (α-Cygni).

A full account of the work will be published very soon.

NALINI KANTA SUR.

Allahabad,
September 25.

"Evolution at the Crossways."

I MUST protest that from the notice of my book on "Evolution at the Crossways," in NATURE of October 4, no reader can get a correct impression of what my theory really is.

The reviewer makes me speak of "righteous" or "unrighteous" insects, for example. But I have specially guarded myself (p. 11) that the bio-morality which I posit does *not* involve conscious morality or really ethical praise or blame. I speak (only rarely and in a general way) of "biologically" righteous and "biologically" unrighteous conduct, *i.e.* in respect of the interdependence of life, of mutual relations. More commonly, however, I use instead the terms "cross-feeding" and "in-feeding" species. My thesis is that "Nature abhors perpetual in-feeding"—the analogue of Darwin's aphorism regarding "in-breeding." The difficulties the reviewer has with my theory are more apparent than real. Have his sharks or echinoderms anything to boast of? Have the molluscs, numerous though they be? They reached their highest development in the massive and almost mindless cuttle-fish. Most of these are indeed predatory and carnivorous. What has it led them to?

The critic's "agriculture" argument is beside the point, unless he intends to be more anthropomorphic than I am. Surely species may be retrogressive, though still of some use to man.

H. REINHEIMER.

103 King Charles' Road,
Surbiton, Surrey,
October 9.

MR. REINHEIMER may justly claim that only from his words can a reader get a correct impression of the theory. On page 12, we read: "Everything abnormal and pathological is due to biologically unrighteous, *i.e.* fundamentally predatory behaviour. Although predaceous species may apparently, and for a time, live quite well, yet their temporary success is at the expense of permanent survival." On p. 186, "All predaceous animals are on the road to ugliness." On p. 87, "The wages of biological sin are: deformity, inferiority, disease, degeneration, death."

There are no apparent difficulties with Mr. Reinheimer's theory. Sharks and echinoderms may "boast" of having been biological sinners and "in-feeders" since Silurian times without incurring any of the five penalties of p. 87. The brain of the cuttle-fish is not less developed than that of herbivorous molluscs, The inferiority of eagles and whales is not self-evident. nor the deformity of cats and sea-birds, nor the ugliness of mackerel and king-fishers. G. P. B

The Glow of Phosphorus.[1]

By the Right Hon. LORD RAYLEIGH, F.R.S.

THE discovery of phosphorus was one of those which is associated with the transitional period when magic and science flourished to some extent side by side, and when the borderline between them was not very well defined. The discovery seems to have been made by the alchemist Brand, of Hamburg. But in those days scientific discoveries were often cherished as valuable secrets, not so much for their commercial value as for the sense of superior knowledge and power which their exclusive possession was supposed to give. Scientific secrets are sometimes jealously guarded now, but not for this reason. When reticence is observed, it is for the less romantic motive of commercial advantage. In the absence of this motive, the scientific men of to-day tell all they know, and tell it without delay.

The subject of phosphorus emerged into daylight in 1678, when Kunkel, who had learnt the secret by word of mouth, made it public. In 1780 the Hon. Robert Boyle deposited a paper on the same subject with the Royal Society. He had worked it out anew, without more than the hint that phosphorus came from an animal source.

It was a long time before the nature of the luminosity of phosphorus was finally settled. The early investigators not unnaturally classed it with the substances which become luminous by exposure to light, such as impure calcium sulphide. This notion survives in the word "phosphorescence," which is after all purely descriptive of the property of giving light. Now, however, the word is usually reserved for the cases like calcium sulphide. Phosphorus is not commonly spoken of as phosphorescent; its luminosity, as every one now knows, is due to slow combustion in the oxygen of the air. It took a long time to prove this, and the question was still in a measure open down to the year 1874. The doubt arose partly from the extremely small quantity of oxygen necessary to make the phosphorus visibly luminous. Accidental leakages may thus confuse the question. Another puzzling circumstance was that when oxygen was substituted for air the glow was extinguished. This can be shown by means of a large flask containing phosphorus dissolved in olive oil. Though the flask may be full of oxygen, the phosphorus is quite dark. When, however, some of the oxygen is removed by means of an air-pump, the phosphorus suddenly blazes out at a lowered oxygen pressure. The same result may be shown by substituting air for oxygen.

This is not the only peculiar thing about the behaviour of glowing phosphorus. When a piece of cotton wool moistened with bisulphide of carbon is held above a dish containing an oily solution of phosphorus, so that the vapour can stream down from it on to the glowing surface, the vapour has an almost magical effect. It stops the phosphorus glowing altogether. In a little time, the small quantity of vapour gets dissipated, and the phosphorus glows again.

Bisulphide of carbon is only one example of many vapours which will behave in this way. Ammonia, camphor, ethylene, turpentine, and essential oils generally, will do the same thing, though they vary widely as to their effectiveness. The majority of permanent gases have little effect in this way, though I am not prepared to say what they might do at high pressure.

It will probably be admitted on consideration that the action of oxygen is not essentially different from that of the other inhibiting substances. As will be explained shortly, the action occurs between oxygen and phosphorus vapour. A little oxygen is necessary to unite with the vapour as it comes away from the phosphorus surface, but the density that is of any use in this way is very small. If, for example, we have a millimetre of oxygen pressure, there will be in the gas space many oxygen molecules for one phosphorus molecule, and a further increase can scarcely promote the combustion. The action of a great excess of oxygen, as when we admit it up to atmospheric pressure, must be something quite different. There is therefore no real paradox in the quenching by an excess of oxygen. Perhaps this analogy may help to explain the action: A man cannot live without water; if he does not get it he will die of thirst; yet if he swallows too much he may be drowned. The water acts in quite different ways in the two cases, and so does oxygen in contact with phosphorus.

Another very strange thing happens when phosphorus is used to get rid of the last traces of oxygen in gas analysis. Suppose that we start with air in a confined space, and put a piece of phosphorus into it. At first the light is confined to the surface, but as the oxygen approaches exhaustion, the light is seen to become diffused throughout the volume of the vessel. It is easy to understand why this happens. Phosphorus is appreciably volatile at the ordinary temperature. When the surrounding oxygen is abundant it snaps up the phosphorus vapour at once, before it can diffuse away from the surface. But when oxygen becomes scarce the phosphorus has the chance to get some distance before this happens. This much is easy to understand. But if we look closely we see that the glow is not steady, but shows moving clouds of luminosity, most curious to watch. Any one can readily try this experiment. Nothing more is required than a piece of phosphorus stuck on a wire and introduced into a bottle standing inverted with its neck under water.

My own work on the subject started from this experiment, which I tried to develop into something more definite than clouds of vague outline moving in an ill-defined path. Fig. 1 shows an attempt in this

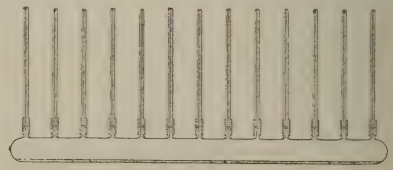

FIG. 1.

direction which had some success. The idea was to constrain the luminosity to move in one direction only. The horizontal tube has a layer of phosphorus lying along the bottom. The long narrow vertical tubes allow air to leak in slowly. When the oxygen originally in the tube is nearly exhausted, luminous pulses are

[1] Discourse delivered at the Royal Institution on Friday, June 6.

e to spring into existence at the side openings, to divide, and to travel along the tube. Usually this happens predominantly at one or two particular places. Pulses travelling along the tube in opposite directions kill one another when they meet.

This arrangement was set up in a dark room, and watched from time to time. After the lapse of a week or more a change was noticed. Although nothing had

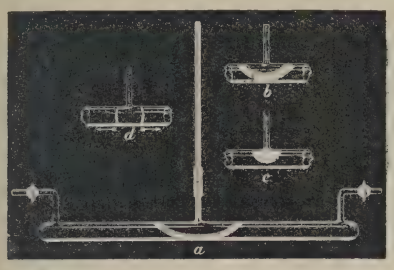

Fig. 2.

been touched, the movements were less lively, and the light had become stationary in places. Finally, all movement ceased.

What could be the explanation of this? The phosphorus had originally been melted into the tube under water, for safety, and the water was, so far as possible, poured off. But, of course, it could not be got rid of completely in that way. The oxides of phosphorus produced by the combustion are greedy of water, and these had gradually dried the tube. On adding water the movements began again.

The next illustration (Fig. 2) shows a similar tube, with only one capillary entrance at the middle. It was pumped out on the mercury pump in the first instance, and filled with nitrogen. A perfectly steady cloud of luminosity is seen when atmospheric oxygen begins to mingle with phosphorus vapour; *a*, *b* and *c* show successive stages as the oxygen influx is increased. If a drop or two of water is added a succession of luminous pulses starts at the side entrance, divides, and travels in opposite directions along the tube (Fig. 2, *d*).

Why does the luminosity move when there is water, and remain steady when there is none? It is evident that the travelling pulses represent the propagation of a wave of chemical action along the tube. There is a mixture of oxygen and phosphorus-vapour ready to unite. It does not at once do so, but chemical union is determined by the passage of the wave, just as in the firing of a train of gunpowder. Nothing of this kind seems, however, to happen in the absence of water. The water holds up the combustion.

Now that matters have been brought to this point, we may recall the experiment in which phosphorus was prevented from glowing by the presence of bisulphide of carbon vapour. Water, it is evident, acts like the other inhibiting substances, but less powerfully. This naturally suggests that we might get the travelling pulses on a more impressive scale by using a more powerful inhibitor than water. It is not desirable to have too powerful an inhibition, however, and I have found that camphor succeeds as well as anything. If a long horizontal glass tube with a mixture of camphor and phosphorus lying on the bottom is exhausted with an air pump, and air is allowed slowly to leak into it through a fine adjustment valve at one end, bright luminous flashes pass down the tube at short intervals. The camphor vapour holds up the combustion until enough air has leaked in to make a mixture of favourable composition, the combustion starts, and the wave is propagated. The period evidently depends on how strong is the inhibiting action. Ammonia is a convenient inhibitor for illustrating this, for its action may be made as powerful as is desired by using a more concentrated solution. The period of the flashes is increased accordingly. The moving clouds of luminosity observed when the absorption of oxygen by phosphorus is nearly complete, are thus linked up quite naturally with the existence of inhibiting substances.

Another series of experiments bring out a further unification of the same kind. They began with the repetition of an interesting observation by L. and E. Bloch, which showed that if some phosphorus was placed in a glass tube, it was possible to blow the glow away from it by a blast of air, and maintain it at a distance downstream. In this form the experiment is rather difficult of control, sometimes succeeding and sometimes failing, for no very apparent reason; but I found it ultimately to be a matter of temperature, a few degrees making the whole difference. Fig. 3 shows the arrangements made by me to bring this under satisfactory control. The phosphorus is a thin flat strip, cast into a suitable recess in the side of a water tank; thus its temperature cannot differ much from that of the water. The latter can be varied at pleasure by the use of ice or warm water. A flat sheet of glass is held at a distance of a millimetre or two parallel to the phosphorus slab, and the air flows between the two, being confined by suitable packing strips at the sides. The channel is prolonged downstream of the phosphorus, and is made suddenly deeper about two inches down.

The accompanying photographs (Fig. 4) illustrate the effects obtained. No. I shows how the phosphorus surface looks without any blast. V shows the glow blown right off, and maintaining itself downstream, where the channel is deepened. The dotted line (inked in on the photograph) shows the position of the phosphorus slab, which is quite dark. This is essentially the Blochs' original experiment. Interesting as it

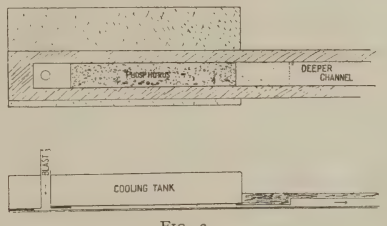

Fig. 3.

is, however, it by no means exhausts what we can learn with the arrangement described.

The effect of changes of temperature was examined, adjusting the blast in each case so that the glow was blown half-way down the phosphorus strip. The velocity of blast necessary to do this was found to diminish enormously as the temperature was reduced. Thus in cooling from room temperature to near the freezing-point, the velocity diminished a thousand times. I next tried altering the oxygen content, and

found to my astonishment that enriching the air with oxygen had the same effect as cooling, and diminished the necessary velocity of blast in an equally striking degree. In both these cases the ultimate result, when the velocity had been reduced to something of the order of 1 cm. per second, was to make the glow flickering and uncertain of maintenance. On cooling a little more, or adding a little more oxygen, it went out altogether.

Now we must remember a fact, often enough insisted upon nowadays, that motion is relative. We have thought so far of the blast acting on the stationary cloud of luminosity, but we might equally regard the cloud of luminosity as propagating itself in the reversed direction through still air. When the air is much enriched with oxygen the necessary blast is gentle—

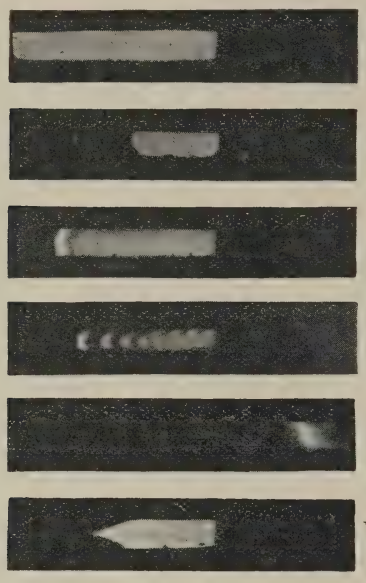

FIG. 4.

in other words, the propagation is slow. It appears then that *extinction is the limiting case of slow propagation*. If we can trace the cause of slow propagation the cause of extinction will not be far to seek.

Before passing to this, however, attention may be directed to some curious effects met with in the course of these experiments on the blast. The same sequence of changes occurs whether we reduce the temperature or increase the oxygen content. Suppose, for definiteness, that the latter course is followed. When the oxygen is very little, the glow tends to cling to particular spots, from which it cannot readily be detached. II shows this to some extent, though other experiments were made in which it was much more striking. On close examination it appeared that these special spots were depressions in the phosphorus surface, where there was partial shelter from the blast. At these places the glow started, and when once started, it infected the gas downstream of it, and made the blowing away impossible. VI shows this very clearly. In this case a hole was made intentionally.

As the oxygen content is increased a bright luminous head develops, followed by a darker space, and then uniform luminosity (III). This bright head no doubt represents the combustion of the stock of phosphorus vapour accumulated as the blast passes over the dar surface.

The next stage, IV, is observed when the blast is s rich in oxygen that extinction is near. A succession of bright heads separated by dark spaces has no developed. This photograph was given four hours exposure, and was not easily obtained: for some movement of the luminous heads is difficult to avoi during so long a time. The heads were seen quite regularly distributed along the column. The confusion on the right-hand side is due to unavoidable shifts.

The question arises as to why this propagation should occur at all, and why it should be slower when excess of oxygen is present. In the analogy of a train of gunpowder there is no doubt that propagation occurs primarily because each layer that has begun burning heats up the next layer, and causes it to burn too. In the case of phosphorus this explanation is scarcely tenable, because the phosphorus vapour present is only a very small fraction of the atmosphere in which it is contained, and it can be calculated that it cannot yield enough heat to raise the temperature more than a degree or two, which would not be enough.

We must look for some other way in which the action in one layer can help the action in the next; and the suggestion I make is that the action is of the kind called catalytic. It is true that this explanation is incomplete and in a measure speculative. On the other hand, it covers many facts otherwise very hard to co-ordinate. One of the most striking peculiarities of catalytic actions is the facility with which the catalyst is *poisoned*. The exact condition of a surface capable of producing this effect is a very critical thing, and I believe that when the glow of phosphorus is inhibited, it simply means that the particles of phosphoric oxide, or other product of combustion, are spoilt, or *poisoned* by the condensation of molecules of the inhibiting substances upon them; and that this prevents them from assisting the propagation. It is noteworthy that most of the inhibiting substances are easily condensable vapours, such as would be likely enough to act in this way. Oxygen is an exception, but it must be noticed, first, that oxygen will only act when moist; and, secondly, it has to be present in enormous excess—about 20,000 molecules of oxygen for one of phosphorus vapour—before it can quench the glow. Inhibitors like ammonia doubtless act by definite chemical union with phosphoric oxide.

Lastly, the view here explained requires us to suppose that the combination is always breaking out sporadically at isolated centres, though in the presence of an inhibitor it fails to propagate itself. I have recently been able to prove directly that this does in fact happen when oxygen is the inhibitor. When the gas-pressure was lowered the phosphorus glowed; but when it was raised again the phosphorus went out abruptly, like a candle blown out. Nevertheless, under the latter condition, it was found by observations lasting over several weeks, that a slow absorption was going on all the time, and that this action occurred between oxygen and the *vapour* of phosphorus.

This whole research has been rather off the main stream of scientific inquiry at the present time; but it shows that there is still a fascinating field for research about phenomena which have been familiar for centuries.

The Malaria Treatment of General Paralysis.

By Prof. WARRINGTON YORKE, M.D.

UNTIL recently the outlook for patients suffering from the disease known as general paralysis of the insane was practically hopeless. For many years, however, it has been known that the symptoms sometimes exhibited remarkable remissions, the delusions and other mental disturbances subsided or even disappeared for a time, whilst the physical condition underwent a similar improvement. It had been further observed that these remissions were often associated with some intercurrent disease, and attempts were made to induce them artificially by such measures as the production of abscesses or injection of bacterial toxins. The improvement was, however, only transient; sooner or later the mental symptoms reappeared, the patients returned to the asylum, and the disease pursued its relentless course to a fatal termination. In 1919 Wagner v. Jauregg of Vienna, as the result of many years' observation of general paralysis, concluded that possibly it was the rise of temperature, which accompanied the intercurrent disease, abscess formation, or vaccin inoculation, that was in some way responsible for the improvement produced in the nervous condition. With the view of testing this hypothesis, he set about to search round for an infection which could safely be administered to the patients and could, after it had run the necessary course, be readily controlled by the administration of drugs. Two diseases occurred to him, namely, malaria and relapsing fever; and after preliminary trials it was found that the former was the more satisfactory. Wagner v. Jauregg therefore proceeded to infect a long series of general paralytics with malaria, and during the years 1920–21 published results of a most promising nature.

It was the publication of these papers that induced L. Clark, the Medical Superintendent of the County Mental Hospital at Whittingham, to test the treatment at his institution; and in July 1922 a number of general paralytics were infected by inoculation of blood from patients who had contracted malaria in the tropics and had come to the hospital of the Liverpool School of Tropical Medicine for treatment. These general paralytics in due course developed typical malaria, and from them other paralytics were inoculated, and so on, the malaria strain being preserved by regular passage from one paralytic to another. Later, the work was commenced at the other mental hospitals of the neighbourhoods, namely, Rainhill, Winwick, Ilfast, and Chester.

For various reasons it was decided in a number of instances to modify the mode of infecting the patient, and, instead of producing the disease by the inoculation of malaria blood, to do so by Nature's method; *i.e.* by the bite of infective mosquitoes. The mosquitoes used were two commonly found in Great Britain, namely, *Anopheles maculipennis* and *Anopheles bifurcatus*, and for a constant supply of the former we are greatly indebted to Mr. Rees Wright, of the Department of Zoology, University College, Bangor, who during the winter collected the hibernating females in farm buildings in Carnarvonshire.

Up to April 1924, at the various institutions mentioned and at the Royal Infirmary in Liverpool, 139 cases of general paralysis had been infected with malaria, 98 by the method of direct inoculation of infective blood withdrawn from malaria patients, and 41 by the bites of infective Anopheles. A sufficient time has now elapsed to enable a judgment to be formed regarding the effect of the malaria treatment in respect of 84 of these patients. Summarising the opinion of the medical experts at the mental hospitals, we find that of the 84 patients, fourteen (16·6 per cent.) have died, most of them immediately, or shortly after the completion of the course of malaria treatment; although all these cases had been treated with quinine before death, and parasites had disappeared from the blood, nevertheless it is impossible to affirm that in none of them was death accelerated by the malaria. No noticeable change in mental or physical condition has been observed in twenty (23·8 per cent.); with regard to these cases, however, it is to be borne in mind, as the mental hospital doctors have frequently pointed out, that in the ordinary course of events many of them would now be dead. In ten (11·9 per cent.) there is definite physical improvement but no change in the mental condition. In seventeen (20·2 per cent.) there is great physical and distinct mental improvement. Finally, in twenty-three (27·4 per cent.) the mental and physical improvement has been so great that the patients have been, or are about to be, discharged from the mental hospitals.

It is to be noted that in a number of the cases the improvement has been maintained for many months —in some for so long as a year—and that quite a number are back at their old occupations. As time goes on, it may be found possible to discharge still others of these 84 cases, for, as Wagner v. Jauregg writes: "The maximum of the improvement does not manifest itself at once at the end of the period of fever, but does later. On the contrary, the improvement continues often for a long period, so that in many cases the result seemed to be an incomplete one where later, however, a complete remission came to pass."

Whether the improvement is temporary or permanent, time alone can decide, but the results already achieved can only be regarded as remarkable, when it is realised that no patient suffering from general paralysis had previously been discharged from the mental hospitals in question.

A number of hypotheses have been advanced to explain the mechanism whereby the one disease produces a beneficial action on the other disease; but as none of these hypotheses are based on any substantial foundation, nothing is to be gained by discussing them here.

As might be expected, work of this nature has enabled us to observe malaria in exceptionally favourable circumstances, and as a consequence much has been learned regarding this disease, and many hitherto unsolved problems have been answered. From this point of view the natural infections, *i.e.* those produced by the bites of infective Anopheline mosquitoes, have been especially valuable. They have enabled us to prove beyond all doubt that the three common malaria parasites are all true species and not merely different

stages of the same parasite, as has been so long maintained by Laveran and numerous other observers of the French school. The incubation period of simple tertian malaria — that is, the period which elapses between the bite of an infective mosquito and the development of symptoms and the appearance of parasites in the peripheral blood—has been shown to vary between 9 and 22 days; and much has been learned regarding the clinical course of the disease.

In striking contrast to the cases of malaria which occurred in such enormous numbers during the War, and those with which one has to deal in the ordinary practice of tropical medicine, the general paralytics were readily cured of their induced malaria by a three-days course of quinine, and relapses were remarkably rare. Why this should be so is a question of no mere academic interest, but one of great practical importance and one to which my colleague, Dr. Scott Macfie, and I devoted much thought and work. As the result of a most careful analysis of all the facts available, the conclusion was reached that the remarkable susceptibility to treatment exhibited by the cases of induced malaria is bound up with the fact that in these cases one is concerned with the early treatment of the disease, or, in other words, with the treatment of primary infections.

In our opinion the train of events in the treatment of malaria is as follows: quinine given to a patient whose blood contains numerous malaria parasites invariably destroys—probably indirectly, *i.e.* after it has been changed in some manner by the human body—large numbers, but not all, of the parasites, and by this means sets free a considerable quantity of soluble antigen. The antigen provokes, by stimulation of the host's tissues, the formation of immune-body. The immune-body, if sufficient in amount, destroys the remaining parasites, thus resulting in sterilisation of the infection and in the cure of the patient. When, for any reason, the host is unable to produce immune-body in sufficient amount, the infection is not sterilised and a relapse occurs. We surmise that certain individuals are unable to produce a sufficiency of immune-body to sterilise the malaria infection, possibly owing to inadequate treatment at the time of the fir attack, possibly owing to ill-health at the time infection and treatment, or possibly owing to a person idiosyncrasy. Whatever be the cause, these are t patients who develop into chronic relapse cases malaria; such patients can no longer be cured b quinine, not because the parasites they harbour a quinine resistant, but because, owing to a defecti formation of immune-body at the time of the initi attack and treatment, the parasites have not bee completely destroyed and have gradually acquired a immune-body resistance. If this view be correct, indicates the paramount importance of adequate quinin treatment at the time of the initial attack of malaria a course of treatment which suffices to sterilise th primary malaria infection fails to prevent the occu rence of relapses when administered to a case of som standing, and this explains the complete lack of succes which followed the most drastic efforts to sterilise th infection in the patients invalided with malaria t Great Britain during the War.

Whether the daily taking of quinine will protect fro malaria those living in the Tropics, and subject to th bites of infected mosquitoes, is naturally a questio of the greatest importance. Notwithstanding th enormous literature bearing on the subject, no precis information has hitherto been obtained, mainly owin to the great practical difficulties which surround an attempt to make observations from which it would b possible to draw conclusions free from very obviou fallacies. The present investigation has, howeve provided the answer to this important question. Ou observations showed that the administration of quinin before a person is bitten by an infected mosquito i useless, and that the drug has little if any action o the sporozoites injected by the mosquito. In order t prevent the malaria from developing, the administra tion of the drug must be continued for at least te days after the feed of the infective mosquitoes; th daily dose of quinine given has but little influence apar from the fact that, with very large doses (30 grains), th period for which the drug has to be given to preven development of the infection is a little shortened.

Obituary.

Dr. W. B. Hemsley, F.R.S.

WILLIAM BOTTING HEMSLEY, whose death, in his eighty-first year, took place at Broadstairs on October 7, was born at East Hoathly, Sussex, on December 29, 1843. A member of a family which had a long and honourable connexion with horticulture, Hemsley's knowledge of plants began with his knowledge of the alphabet. Being a somewhat delicate child he had to be educated privately, and before his education had been completed, in order to lead, so far as possible, an out-of-door life, he began his training as a gardener in his father's establishment. Already his taste for botanical pursuits was so marked that, as soon as his training had been completed, he entered Kew as a young gardener in 1860, when in his seventeenth year.

Before the period of two years to which the service of a young gardener at Kew is normally limited, Hemsley's remarkable botanical aptitude had so impressed both the Curator and the Director that h was transferred from the garden to the herbarium Here young Hemsley's capacity attracted the attentio of Mr. G. Bentham, who was then at work on his grea "Flora Australiensis," in the preface to the firs volume of which reference is made to Hemsley' services. While a temporary technical assistant i the herbarium, Hemsley gave all his spare time t general botanical studies; in 1863 he gained a firs prize in botany, awarded by the Royal Society of Arts In 1865 a vacancy occurred in the permanent her barium staff, and Hemsley was selected to fill it. Bu Hemsley's physique could not stand the strain to which the enthusiasm and assiduity with which he performed the duties of Herbarium Clerk subjected it. In 1867 a complete breakdown in health compelled Hemsley, to the regret of his superior officers, to relinquish his clerkship and retire to Sussex. Here, in spite of his illness, Hemsley devoted himself to mastering Latin,

Linnean, and French, and continued his botanical pursuits, the results of which were embodied in a "Handbook of Hardy Trees, Shrubs and Herbaceous Plants," still highly esteemed by gardeners, and in an "Outline of the Flora of Sussex," prized by local botanists. So high was the standard Hemsley had set himself and had attained, that in 1875 the Linnean Society elected him one of its botanical associates.

By 1874, Hemsley's health, though still indifferent, justified his return to Kew as an independent worker. During the next nine years he was engaged principally on the task of elaborating the phanerogamic material obtained during the cruise of the *Challenger*, and of describing the botanical collections of Messrs. Salvin and Godman. The *Challenger* report was published in 1885, and secured for Hemsley the position of a recognised authority on insular floras. The botanical work done on behalf of Salvin and Godman was published in the five botanical volumes of their great "Biologia Centrali-Americana," issued at intervals during 1879–1888; the extraordinary value of this Mexican flora was recognised, so soon as it was completed, by Hemsley's election to the Royal Society in 1889.

Meanwhile Hemsley's health had, happily, become completely restored, and in 1883 he once more was able to join the permanent staff of the herbarium at Kew as assistant for India. In 1890, when Prof. D. Oliver was succeeded by Mr. J. G. Baker as Keeper of the Herbarium and Library, Hemsley was appointed a principal assistant in succession to Mr. Baker, and in 1899, when the latter retired from the public service, Hemsley again succeeded Baker, and served as Keeper of the Herbarium and Library at Kew until his own retirement, at sixty-five, on December 28, 1908. While assistant for India and principal assistant, Hemsley was able to prepare his invaluable work on the flora of China, which occupies three entire volumes of the Linnean Society's Journal. During this period, too, he collaborated with Dr. J. E. T. Aitchison in working out the botanical results of the Afghan Boundary Commission, with Sir Henry Collett in doing the same for the Shan Plateau, and with Mr. H. H. W. Pearson in writing a valuable "Flora of High Asia." He was also the author of many smaller, but always important, botanical contributions, mainly of a systematic character. He took a share, with other members of the Kew staff, in the preparation of the "Flora of Tropical Africa," and assisted Sir Joseph Hooker, after his retirement in 1885, in connexion with the *Botanical Magazine*, which Sir Joseph continued to edit after he had ceased to be Director of Kew.

As Keeper of the Herbarium, Hemsley found his time very fully occupied with official duties, and although many minor contributions to botanical literature were still made by him, he wisely avoided undertaking any task so formidable as those accomplished in his earlier years of active work. After his retirement Hemsley continued this policy for another reason. He did not care to undertake a task he might not have strength to complete. His work on the matters he took up remained, however, as excellent as ever, and was continued until failing physical powers necessitated his seeking a home in a climate more bracing than that of the Thames Valley.

Hemsley's labours were appreciated as highly in other countries as in his own. His contribution to the "Biologia Centrali-Americana" brought him honorary membership of the Natural History Society of Mexico; his knowledge of insular floras brought him honorary membership of the Royal Society of New South Wales, and of the New Zealand Institute, and corresponding membership of the German Botanical Society. His services to garden-lovers brought him honorary membership of the Royal Horticultural Society and the award of its Victoria Medal of Honour. In 1896 the Linnean Society accorded him, at his own request, transfer from associateship to fellowship, and in 1918 the University of Aberdeen conferred on him the honorary degree of LL.D.

The courtesy and consideration which made collaboration with Hemsley as a botanical author as pleasant as it was profitable to those thus privileged, made the relationship between himself as Keeper and his colleagues in the Herbarium equally cordial. Not they alone, but all who ever came in contact with Hemsley will treasure the memory of one whom they esteemed for a kindness as genuine as his sincerity, for a knowledge as remarkable as his modesty.

Lord Abercromby.

Archæological circles in Scotland have lost one of their most distinguished figures by the death of Lord Abercromby, which took place at Edinburgh on October 7 in his eighty-third year.

John, fifth baron Abercromby of Aboukir and Tullibody, was born on January 15, 1841. He was a great-grandson of General Sir Ralph Abercromby, who died from wounds at the battle of Alexandria in 1801, and whose widow was created a baroness. Lord Abercromby succeeded to the title on the death of his brother in 1917. He was educated at Harrow, and for some years held a commission in the Rifle Brigade. After his retirement he took up the study of philology, folklore, and archæology. His publications were not numerous, but they were characterised by accuracy, scholarship, and judgment. Although not all of his conclusions have found acceptance, some of his views, especially those relating to the origin and distribution of Bronze Age types of pottery, have had a profound and widespread influence on the trend of archæological thought. One of the earliest of his publications was "A Trip through the Eastern Caucasus." Better known was his "Pre- and Proto-Historic Finns," in which he traced the history of the Eastern and Western Finns from neolithic times to the Middle Ages, analysed their religious beliefs and folklore, and translated their traditional magic songs. This valuable piece of work was recognised by election as an honorary member of the Finnish Archæological Society and the Finno-Ougrian Society of Helsingfors. His most important work, however, was his "Bronze Age Pottery of Great Britain and Ireland," which appeared in 1912; this was a gathering together and elaboration of the views which he had expressed in various scientific periodicals in the preceding ten years or more. A further notable contribution to the study of prehistoric ceramics appeared in the Journal of the Royal Anthropological Institute for 1914 under the title "The Prehistoric Pottery of the Canary Islands and its Makers."

Lord Abercromby was a fellow of the Royal Society of Edinburgh and an hon. LL.D. of the University of Edinburgh. He was a vice-president of the Folk-lore Society and formerly president of the Society of Antiquaries of Scotland. In 1921 he presided over Section H (Anthropology) of the British Association at the Edinburgh meeting, and when, in the following year, a local branch of the Royal Anthropological Institute was formed at Edinburgh, he was unanimously elected the first president. His tact and charm of manner, his never-failing courtesy to all, and his assiduous attention to the duties of the offices he held, notwithstanding failing health, won the affection and respect of all with whom he came into contact. As Lord Abercromby leaves no heirs male, the title now becomes extinct.

THE death is announced on August 4 last of Dr. Santiago Roth, head of the department of palæontology in the Museum of La Plata, Argentina. Dr. Roth was born in Switzerland and emigrated to Argentina nearly half a century ago, where he became especially skilled in collecting fossil skeletons of mammals from the pampas. He sold many fine specimens to the museums of Zurich and Geneva, and some also to the Zoological Museum of Copenhagen. When the Museu of La Plata was founded, he was employed by the la Dr. F. P. Moreno to collect similar pampean skeleto for that institution, and he was soon appointed to tal charge of the fossils. Dr. Roth added much to o knowledge of the pampean formations, which l studied extensively and in great detail, and he al described many of the mammalian remains.

WE regret to announce the following deaths:

Dr. Edouard G. Deville, I.S.O., Director-General Surveys in the Canadian Department of the Interio and author of "Astronomic and Geodetic Calcul tions" and "Photographic Surveying," on Septemb 21, aged seventy-three.

Dr. E. O. Hovey, curator of the Department Geology and Invertebrate Paleontology of th American Museum of Natural History, on Septembe 27, from a stroke received in his office on the pr ceding day, aged sixty-two.

Dr. C. W. Moulton, professor of chemistry sinc 1894 at Vassar College, New York, on September 1 aged sixty-five.

Dr. J. M. Schaeberle, formerly at the Lick Observa tory, and author of a number of papers on astr nomical subjects, aged seventy-one.

Current Topics and Events

THE Everest Expedition of 1924 reported to a joint meeting of the Royal Geographical Society and the Alpine Club before a distinguished assembly in the Albert Hall on October 17. Earlier in the day a memorial service for Mallory and Irvine was held in St. Paul's Cathedral. Pioneers like Drake and Livingstone, these two perished, as did Scott and Shackleton, in an attempt to go one step beyond the bounds hitherto set to human endeavour, and their names in their simplest form will be treasured in the national memory. Both were Cheshire men, and the Bishop of Chester embodied the spirit of the impressive service under the famous Cathedral dome in an address which showed how the two mountaineers, now at rest in the most magnificent cenotaph in the world, were great climbers because they were great men full of courage, unselfishness and cheerfulness, men who had attained to great spiritual heights, men who had risked life itself in the service of others. Odell, who was in support, was climbing to Camp VI. on June 8 by a circuitous route. He discovered fossils in a band of limestone, and found himself enveloped in mist with clear sky above. By a mere chance he climbed a crag and emerged into a sudden temporary clearing of the mist to a vision of the summit ridge and peak of Everest. Far away on a snow slope near the base of the final pyramid he saw two figures climbing slowly towards their goal, one reaching out to help the other, then the mist fell again. The time was 12.50, and Mallory and Irvine were three hours late on their time schedule, yet they were pressing on. The chances are that they were speeding to the accomplishment of the little bit more which meant so much. Odell believes they got to the summit and were benighted on th return journey. *Sic itur ad astra*. The sure recor stands that Mallory and Irvine climbed to 28,23 feet with the help of oxygen. On another attempt Norton and Somervell reached 28,130 feet withou oxygen, and this presages a future success by similar effort which will probably be made in 192 Other records were Odell's three ascents betwee 25,000 and 27,000 feet within a week, the carriag by six porters of loads to a height of 27,000 feet men have slept well in camp at 26,800 feet. Th upper half of Everest consists of slabby altered lime stones, a 1000-feet thickness of sandstone and fossil has been found, and in 1924 persistent cold wind blew from the west with night temperatures whic fell once to −22° F. At Camp IV., 23,000 feet twice in June, the noon sun temperature was 105° F. while the air temperature was only 29° F.

THE broadcasting last week of the speeches of th leading politicians of Great Britain proves that th influence of radio communication on the lives an affairs of men is already very great. Mr. Reith, th manager of the British Broadcasting Company, i an article in the October *Quarterly Review*, gives a account of the present position of the art and indicate some possible future developments. In less than two years the staff has increased from 4 to 350, and operations are now carried out nightly in twenty cities. A system of simultaneous broadcasting has been carried out for more than a year, and practically a million licenses have been issued. There are very few "blind spots," that is, regions which suffer appreciably from shielding, due possibly to hills,

ire reception is in consequence difficult. In the ightly audience every grade of society, every t dard of intellectual attainment, and every variety f aste are represented. The managers aim at giving sa sfaction to three-quarters of the audience, three- rters of the time. Their aim is both entertain- nt and instruction, and the educational possi- ilies are being rapidly developed. By the aid of h master microphone a single man can influence a ti on, and through its agency the ideals of universal br herhood can be broadcast over the whole world. At the present moment, by means of the cheapest rstal set, about 75 per cent. of the total population of Great Britain can listen in. A large fraction of h remaining 25 per cent. will be covered when the ni power station thirty miles north of London is opned next year. This station has a guaranteed ge of 100 miles for cheap crystal sets, 300 for gle-valve sets, and about 1000 for two-valve sets. Th Bethnal Green Borough Council recently ggested that they should erect a central aerial to sp ply the district, and so dispense with the necessity fo independent aerials in every house. We think th t the suggestion is impracticable, while the legality of such a proceeding is open to question; but many o the unsightly and unnecessary aerials hung out by tenants should be prohibited by law. The situation ight be improved if radio manufacturers would advertise more largely the fact that in most cases, wen electric or gas lighting is used, an aerial is unecessary even with crystal sets.

Sir Arthur Evans, in the *Times* of October 16 and 17, gives a further account of his work in Crete during the present year. Investigations of the neo- lithic remains immediately below the Central Court have brought to light three fragments of stone vessels to be related to the early Nilotic lapidary work. They are the first to be found in pure late neolithic floor deposits. Vessels of predynastic form and material had already been found at Knossos, but in unstratified earth. This discovery throws back the actual contact between Crete and Egypt and the closing phase of neolithic culture in the island to the middle of the fourth millennium B.C. The road from Knossos to the south coast has now been traced to a Minoan haven at Como round a headland north of the harbour of Matala. Excavation of the in- durated clay at the point where this road abuts on the hillside below Knossos has revealed further details of the construction of the viaduct across the ravine and the entrance system of the palace, as well as the pavilion or caravanserai at the south-eastern extremity of the viaduct. This building of unique character faces north with a frontage of more than 50 feet. The walls of the pavilion, only the lower parts of which are standing, had been covered with frescoes, of which fragments preserved in the petrified ground have been pieced together and reveal a frieze of a novel character of naturalistic red-legged partridges and hoopoes on a highly conventionalised landscape background. The bath chamber adjacent had an elaborate system of conduit pipes. In an underground "fountain" chamber packed with votive vessels was found a primitive image of a goddess within a vessel shaped like a round hut—the Lady of the Source herself.

The work of Prof. A. Maihle, of the University of Toulouse, on the catalytic effect of various contact materials on a great variety of materials, is well known to the organic chemist, but recent develop- ments, from the point of view of the supply of fuel for internal combustion engines, have attracted considerable attention amongst fuel technologists. At a recent congress held in Paris, Maihle described his work on the pyrogenesis of fatty oils and showed how a copper-aluminium catalyst brought about the rearrangement of linseed oil into a synthetic petroleum. The fatty acid from arachin oil brought into contact with tested magnesium chloride yielded 68 per cent. of a "mineral" oil which contained motor spirit, burning oil, and more viscous components. A similar product was obtainable from chlorophyll, and it appears possible that even cellulose would be capable of yielding hydrocarbons. At the same time, it should be mentioned that the commercial possibilities of this work are probably highly over- estimated. Up to the present date, less than one cubic mile of petroleum has been extracted from the earth's crust, and the world is faced to-day with over-production rather than with a deficit of mineral oil. Even when the known resources of petroleum are exhausted, there are untold volumes of potential liquid fuel derivable from shale, whilst the work of Bergius indicates that even when shales are exhausted, every coalfield is a nascent oil reservoir. In these circumstances it is difficult to see that the production of oil from vegetable sources is other than of scientific interest.

A series of short instructions on the method of taking and reporting readings of temperature and rainfall has been issued by the Meteorological Office, Air Ministry. The pamphlet bears the title of "The Observer's Primer" and was primarily prepared for meteorological observers in British Crown Colonies. The instructions, if carefully considered by observers of the weather, will render the observations made of much greater value. Uniformity of system in observing is of primary importance, and careful readings of temperature and rainfall are of infinitely more value than minuteness in the fineness of reading. Instructions are given as to the exposure of thermo- meters and the position of the rain-gauge. The hints are essentially of value to new observers, and if followed will place the observer on the same footing as one who has already had experience.

Monthly normals of rainfall for the British Isles for periods ending 1915 have recently been published as Section V. of "The Book of Normals" by the Meteorological Office of the Air Ministry. The material has been prepared by the British Rainfall Organisation, which, since 1919, has been incor- porated in the Meteorological Office. Monthly and annual values are given for 578 widely distributed places, compiled from the records for the 35 years

1881 to 1915. This period is chosen chiefly because it probably gives the largest number of synchronous and homogeneous records. Section V. covers the same ground as Section I., but it comprises many more stations; the additional information now available has been utilised for the present issue and where necessary corrections have been made. The arrangement of the stations is the same as that adopted in "British Rainfall" and differs from that of previous sections of "The Book of Normals." It is now easy for any inquirer to compare the very different amounts of rain which occur in different places. The modifications made in Section V. are fairly numerous, as is clearly seen from a careful examination. It is of general interest to see how on the same coast the average rainfall differs; at Eastbourne the total for the year is more than 3 inches heavier than at Worthing, and an excess is maintained in every month of the year. The mean for the 35 years at Greenwich Observatory is about 1 inch less than the mean for 100 years terminating at the same date; for the 35 years the mean for September is 0·47 inch less than December, while for the 100 years, September is wetter than December.

Two hundred years ago this month, the firm now known as Longmans, Green and Co., publishers, was founded by Thomas Longman, an ancestor of some of the present directors, and we are sure that our readers everywhere will join us in offering our congratulations on the completion of so long a period of public service. Thomas Longman was apprenticed to a bookseller in Lombard Street in 1716, and when his indentures ran out in 1724, he acquired the business of a publisher and bookseller in Paternoster Row at the sign of the Ship in Full Sail. That site marks the birthplace of the house of Longman, and it is interesting to note that, with the exception of a short period, 1861–63, when a fire made rebuilding necessary, a publishing business in the name of Longman has occupied the site continuously for two centuries, while the old sign has been adopted as the firm's trademark. From the date of its foundation onward, at least one Longman has been in the firm, and now the sixth generation is in possession. It is a fine example of the inheritance and development of traditions which have led to an important and ever-increasing business. Among the works issued by Longmans with which scientific workers will be familiar are Salmon's "Conic Sections," Herbert Spencer's "Principles of Psychology," Herschel's "Outlines of Astronomy," Webb's "Celestial Objects," and Gray's "Anatomy," which was published in 1858 and achieved its twenty-second edition last year. Then in the 'sixties came Tyndall's Lectures, while of more modern works we may quote Watt's "Dictionary of Chemistry," Sir Edward Thorpe's "Dictionary of Applied Chemistry," Mellor's "Inorganic and Organic Chemistry," which is now in course of publication, J. G. Millais' sumptuous volumes on British ducks and on rhododendrons, and Thorburn's equally beautiful works on British birds and mammals. The firm and its directors have a record of which they may well be proud, and we wish them long and continued prosperity.

THE seventh annual Streatfeild Memorial Lectu will be delivered at 4 o'clock on Thursday, Novemb 6, at the Finsbury Technical College, Leonard Stre E.C.2, by Mr. Julian L. Baker, who will speak " The Chemist and the Fermentation Industries."

THE Thomas Hawksley lecture of the Institutio of Mechanical Engineers will be delivered at t institution at 6 o'clock on Friday, November 7, b Vice-Admiral Sir George G. Goodwin. The subje will be "The Trend of Development of Mari Propelling Machinery."

THE British Association for the Woollen an Worsted Industries is inviting applications fro persons who have engaged in original research for th post of physicist. Applications stating academ qualifications, research work, and technical or engi eering experience, if any, should be sent to the Secr tary of the Association, Torridon, Headingley, Leed

APPLICATIONS are invited from holders of university honours degree in science or engineerin or equivalent, with experience in engineering work for a research assistantship at the Royal Aircra establishment, South Farnborough, Hants, for wor in connexion with aero engines. The application quoting reference No. 37, should be sent to th superintendent of the establishment.

THE Dorset Field Club announces that the Cec Medal and Prize of 10*l.* will be awarded in May nex for the best essay on "Broadcasting: its Possibilitie and Limitations." The competition is open t persons between the ages of seventeen and thirty-five born in Dorset or resident in that county for not les than a year between May 1, 1923 and 1925. Particu lars of the competition are obtainable from Mr. H Pouncy, Midland Bank Chambers, Dorchester.

A REPRESENTATIVE assembly was present at th memorial service for the late Sir William Herdma at the ancient chapel of Toxteth in Liverpool, o Thursday, October 16. The Mayors of Liverpoo and Birkenhead, representatives of the University the various civic bodies, the Royal Society, th British Association, the Marine Biological Association the Liverpool School of Tropical Medicine, the Society of Chemical Industry, and other institutions attended The Unitarian service was conducted by the Rev C. M. Wright, the minister of the chapel.

IN addition to the development of commercia transport by rigid airship, the directors of civi aviation in the United States of America have a programme of semi-rigid airship construction and operation. The latter have the advantage of smaller size, first cost and running expenses, but have less speed, range and carrying capacity, and less ability to ride out a spell of bad weather. Available data are so untrustworthy that it is better to await the completion of the programme rather than to offer anticipations which can be little better than guesses.

THE following committee has been appointed by the Board of Trade to consider and report on the steps which can be taken to bring about the growing

of flax seed and flax in the British Isles on a commercial scale :—Sir Frank Warner (chairman), Mr. Norman Boase, Mr. J. G. Crawford, Sir A. Daniel and Mr. A. L. Hetherington, Sir Thomas H. Middleton and Mr. H. Mead Taylor, together with a representative, to be appointed later, of the Ministry of Commerce of Northern Ireland. The Secretary to the committee, to whom all communications should be addressed, is Capt. S. E. J. Brady, Board of Trade, Great George Street, London, S.W.1.

THE Council of the Institution of Automobile Engineers has made the following awards for papers read during the past session :—Crompton Medal to Dr. Aitchison for his paper entitled "Light Alloys for Pistons and Connecting-Rods," the Utility Prize, given by Col. D. J. Smith for the paper of greatest utility to the automobile industry, also to Dr. Aitchison for the same paper; Graduates Prize to Mr. R. N. Aveline (Coventry Branch) for his paper entitled "Carburation."

IN the Report on the Raffles Museum, Singapore, for 1923, Mr. C. Boden Kloss, who has succeeded Major J. C. Moulton as director, announces that a portion has been given for a new wing on the site recently vacant for this purpose between the museum and the sea. The museum is becoming yet more frequently used by local residents who seek information from a scientific or commercial point of view. From near the summit of Gunong Angsi (2700 ft.), in Negri Sembilan, Mr. F. N. Chasen has obtained a specimen of a martin, *Chelidon dasypus*, the first one recorded from the mainland of the Malay Peninsula.

THE September issue of the Journal of the Franklin Institute gives an account of the presentation on May 21 of the Franklin medals to Sir E. Rutherford and Dr. E. Weston respectively. Unfortunately neither recipient could be present in person, but the former sent an interesting account of the events and ideas that guided him in his early researches in radioactivity, which was read by Dr. J. S. Ames, professor of physics in the Johns Hopkins University. Dr Weston is well known as the inventor of the standard cell, but it is not generally known that he discovered and patented the resistance alloy now known as manganin, the manufacture of which was taken up in Germany. Dr. Weston was born in England in 1850 and went to America in 1870.

THE Technological Museum of Sydney has so high a reputation in Great Britain that it is disappointing to read in its latest annual report that "it has not received that appreciation of the public such an institution deserves." Since the attendance for the year was 43,138, since visits to the museum form part of the work of the elder scholars in the Secondary and High Schools, and since many manufacturers have generously augmented the industrial exhibits, we infer that the director is alluding only to the inadequacy of the State grant. The annual vote, which had been temporarily suspended, has indeed been restored, but the available money is not enough to meet the needs of the central museum and of the six country branches. Let us hope that, as the situation improves, the claims of this admirable institution may meet with due recognition.

IN the October number of *Scribner's Magazine* is an article on predicting earthquakes by Prof. T. A. Jaggar of the Hawaiian Volcano Observatory. Though he refers to one or two successful forecasts of volcanic eruptions, the article is rather a plea for the foundation of a geophysical observatory in New York, a plea supported by an account of an imaginary earthquake in that city in 1932. There is no reason, he considers, for regarding New York or Washington as immune from a shock like that of Charleston in 1886. Prof. Jaggar's view is partly due to a table of seismicity which he has compiled for various regions, depending on the number of earthquakes per year for an average square mile without regard to their intensity. In the eighth degree, he places New York and New England with central California and parts of New Zealand and Mexico. But, in the ninth degree, are included the north of England along with Asia Minor, Messina, and the Lesser Antilles; and, in the tenth and highest degree, Perthshire beside Manila, Guatemala, and Tokyo.

AT the opening meeting for the 1924–25 session of the Institution of Petroleum Technologists, held on October 7, awards of the Institution's medals and scholarships were announced. The Boverton Redwood Medal for the sessions 1919–20 and 1920–21 was awarded to M. Paul de Chambrier of Pechelbronn, for his paper on the "Working of Petroleum by means of 'Shafts' and 'Galleries,'" read before the Institution on February 15, 1921. This medal, presented to the Institution by Mr. Alexander Duckham to commemorate the late Sir Boverton Redwood, founder and first president of the Institution, is awarded to the author of the paper of the greatest merit on any subject connected with petroleum technology, presented to the Institution during two consecutive sessions, and is not confined to members of the Institution. The award has been made retrospective to 1919, the date of Sir Boverton Redwood's death. As there was no paper of outstanding merit for the sessions 1921–22 and 1922–23, no award has been made for those sessions. The Student's Medal and Prize has been awarded to Lieut. J. H. Blakiston, R.N.R., formerly student of the oil technology course at the University of Birmingham, for his paper entitled "The Oilfields of Roumania." This award is made to the student member of the Institution who presents the best paper on any subject connected with petroleum technology, in any one session. This is the first award of this medal and prize. A Scholarship has been awarded to Mr. Ernest Clark, of the Royal School of Mines. These scholarships are awarded annually, one each to the Royal School of Mines, Imperial College of Science and Technology, London, and to the University of Birmingham, to a third year student, taking the petroleum technology course, who is also a student member of the Institution.

A LARGE part of the Report of the South African Museum for 1923 is taken up by the late Dr.

Peringuey's complaint of the delay in providing additional buildings. The large whale skeletons that stood so long in the open—to their considerable detriment—have been covered by a T-shaped building of brick with asbestos roof; but for some reason this was not made large enough to include a fin-whale and a male sperm-whale. Counting these, all the cetaceans known to occur along the coast of the Union are represented, except two porpoises. Special mention is made of *Balænoptera rostrata* and *Neobalæna marginata*, which have not long been known to occur in these waters. Owing to the damaged condition of many skeletons, some new ones are required, but so far only one whaling company, and that a foreign one, has befriended the museum. An old iron and wood building was obtained to store some of the other vertebrate skeletons, and, pending the erection of a wing for which 20,000*l*. was voted in 1914, this has also been used for exhibition purposes. One of the wings of the main building has been lent to the Art Gallery, which also waits in vain for the completion of a promised building. Whatever be the cause, it is certainly regrettable that valuable collections should be suffered to decay for lack of halls and cases.

LAST year at about this time we were able to extend a welcome to the *British Journal of Experimental Biology*, which was the first periodical in Gr Britain designed to cover this important and growi field. Other countries were already served by co parable publications. We now learn that an int national journal of general biology, under the title *Biologia Generalis*, is to be issued shortly under t editorship of Prof. Leopold Löhner, of the Universi of Graz, Prof. Raymond Pearl, of the Johns Hopki University, Baltimore, and Prof. Vladislav Ruzič of the Charles' University, Prague. The list of editors, who will presumably form an editing co mittee, contains the names of biologists from m European countries and also from the United Stat of America. It is proposed to publish origin articles on general morphology, physiology, a ecology, and contributions will be printed in Englis French, German, Italian, or Russian. The pu lishers of the new journal are Messrs. Emil Haim a Co., Vienna 1, Maria Theresienstrasse 10, and Bra slave, C.S.R., or, in the United States, through t Johns Hopkins Press.

MR. H. KIRKE SWANN is publishing, throu Messrs. Wheldon and Wesley, Ltd., in 12 parts, limited edition of "A Monograph of the Birds Prey (Order Accipitres)." The work will be illu strated in colour by H. Gronvold, and the first part promised for November 15.

Our Astronomical Column.

THE ASTRONOMICAL DAY.—In a recent notice in this column of the Brussels Annuaire, it was stated, on the authority of the Annuaire, that the "Berliner Jahrbuch" for 1925 was not participating in the change of the commencement of the astronomical day from noon to midnight. Examination of next year's issue of the Jahrbuch shows that this statement is incorrect; that publication comes into line with all the other national ephemerides, which is a matter of congratulation, as a variety of usage in different countries would be a source of frequent errors. It is not too early to remind astronomers to make the change in any publications relating to next year's work. In a few cases it has been overlooked.

THE STARS OF TYPE O.—An important monograph on these stars by Dr. J. S. Plaskett forms vol. ii., No. 16, of the Publications of the Dominion Astrophysical Observatory. They are the most massive of any type; their mean mass is shown to be some 45 times that of the sun, the probable range being from 10 to 80 times that mass. The mean mass for early B stars (Bo to B5) is 10 times that of the sun.

In spite of the high mass, the O stars have the high average radial velocity (cleared of sun's velocity) of 25·5 km./sec., which is higher than that of any type except the M variables (35 km./sec.). The total space velocity is twice as great.

The close relationship between O stars and planetary nebulæ has been indicated before, but is further demonstrated.

The mean parallax of the O stars is difficult to determine, owing to their small proper motions. It is found to be about 0·0011″ for 6th magnitude stars, indicating a distance of 3000 light-years and an absolute magnitude of $-4^{mag.}$, which agrees with Eddington's mass luminosity relation.

The monograph proceeds to discuss the fix H, K calcium lines, supposed to indicate cosm clouds between the earth and the stars, excited their radiation. The Wolf-Rayet or "Emission O stars are also discussed. Dr. Plaskett adopts t notation of O5 to O9 for the Harvard Oa to Oe. H proposes that the suffix *e* should be used to deno the presence of emission lines.

Many of the spectra discussed are reproduced three plates at the end of the work.

STELLAR DISTRIBUTION.—The researches of M K. G. Malmquist on this subject were recently note in this column. The question of the relative frequenc of the different spectral types, and of the giants a dwarfs of the same type, is of such fundament importance in stellar cosmogony that it is of intere to give for comparison the figures given by Pro Harlow Shapley (*Scientific Monthly*, May 1924) f the numbers of stars of different types contained i a cube the side of which is 100 parsecs; they a Giant M 22, Giant K 160, Giant B 4·4, Giant A 25 Dwarf F 680, Dwarf G (solar type) 7600. He note that Dwarf K and M would far outnumber the las but exact data are not available. He conclud from the small figure for Giant B that extremel few stars have sufficient mass to attain so high temperature. It may also indicate that stars d not remain in this stage for long. Stages K and appear to be much longer.

Prof. Shapley concludes that 95 per cent. of th stars in the Henry Draper Spectral Catalogue ar within 1000 parsecs of the sun; this region is onl one-millionth of that which he believes from hi researches on the clusters to be closely populate with stars. The paper also deals with the galacti concentration of different types. This is great fo B, A, slight for F, G, moderate for K, M.

Research Items.

BABYLONIA AND EARLY INDIA.—In further reference to the discovery of an early Indian civilisation at Mohenjo-Daro and Harappa (see NATURE, October 11, p. 584), it may be of interest to note that the chief points of resemblance between the objects from these sites and Babylonian antiquities to which Messrs. Gadd and Smith direct attention in the *Illustrated London News* of October 4, are as follows:—The seals are similar in shape to square stamp seals from Susa and Babylonia (3500–2500 B.C.), while the engraved bulls on them are distinctly Sumerian both in general appearance and in detail. They stand before a cult object in a position familiar in Babylonian art of all periods, and if the object were a sheaf, this would closely resemble the Sumerian picture sign *Zag*. Of the signs on the seals, obviously some form of writing, nine very closely, and seven partially, resemble Sumerian writing. The numeration system appears to be the same. A cylindrical piece of hæmatite with flattened ends from Mohenjo-Daro recalls a common type of weight from Babylonia. The curious stone rings may be compared to Babylonian mace heads, and, like them, may be votive offerings. Shell inlay, of which pieces have been found, is one of the most characteristic features of early Sumerian culture. The figurine of a cock from Mohenjo-Daro finds a parallel in a clay figurine of a hen from Ur. The style of brick building, with its drainage system and ornamentation of glazed bricks, closely resembles the style of buildings brought to light by the recent excavations at Ur. The miniature funerary pottery from Mohenjo-Daro is similar to miniature pottery from Ur which belongs to the second millennium. Painted pottery from both Susa and Babylonia antedates 3000 B.C. It belongs, however, to a period when metal was only just coming into use, as appears to be the case on the Indian sites.

ANCIENT CLEPSYDRÆ.—In most early civilisations means were devised for measuring time, and in ancient Egypt, while sun-dials or shadow-clocks of various types were used to indicate the passage of time during the day, water-clocks were employed at night. In an article in *Ancient Egypt* for June, Mr. R. W. Sloley describes two of these water-clocks. The older of them dates from about 1400 B.C. and was found at Karnak in 1904; it is now in the Museum at Cairo. In this type the surface of the water in a vase of the shape of the frustum of a cone fell through approximately equal intervals in equal periods of time as the water flowed out through a small orifice at the base. Among the Græco-Roman papyri found by Grenfell and Hunt at Oxyrhynchus is a fragment dating from the third century B.C. in which are given instructions for constructing the scales for one of these "outflow" water-clocks. The second one is probably an "inflow" clock, of which an example dating from Ptolemaic times was found at Edfu. In this type the water chamber is cylindrical, and it would appear that water flowed into it at a constant rate, causing a float to rise, though the lines which are scribed on the inside of the vessel scarcely support this view; on the other hand, they are difficult to see and could not have furnished a convenient means of reading the time directly. Casts of both of these water-clocks and one of a shadow-clock —which was used during the day in ancient Egypt—may be seen in the Science Museum at South Kensington. Thus in ancient Egypt the priests, by observing the culmination of different stars with the aid of a plumb-line and sight-vane, could determine sufficiently for their purposes different hours of the night; and with the water-clocks they could measure the passing of the hours. The shadow-clocks, which showed approximately the number of hours which had elapsed since sunrise, or which remained before sunset, were probably in more general use among the people; the distribution of water by a water-wheel or the working-periods of different pairs of oxen are still checked by little shadow-clocks made of a few pieces of millet (durra) stalk by the cultivator for his guidance.

CHILDBIRTH CUSTOMS AMONG THE INDIANS OF NEW MEXICO.—In *Man* for October, Dr. Elsie Clews Parsons describes a number of interesting customs relating to mothers and children among the Tewa Indians. An eclipse of the moon occurring during pregnancy is believed to cause deformities of mouth, foot, or hand. Therefore an expectant mother carries a key, stone, or something hard in her belt so that "the moon won't eat the baby." At an eclipse "when the moon dies," a woman is told not to go out of doors. The mother lies in for three days; on the fourth day the child is named, the attendant aunts, paternal and maternal, giving the names. In the course of the ceremony one of the aunts, called the navel mother, takes a mouthful of water from an abalone shell which has been used for bathing the child, and in which has been placed a fetish stone. With this water in her mouth she breathes along an ear of corn. The ear is waved in six directions, and the water ejected into the mouth of the infant. This rite is repeated for a second ear. The two ears are left on either side of the child for ten or twelve days. They are planted in the following year. The object of using these sacrosanct ears is that the baby may grow up perfect like the corn ear.

IMPLANTATIONS OF TESTIS AND OVARY.—Knud Sand in *Endocrinology* (vol. 7, pp. 273-301, 1923) gives a summary of his experimental results published in 1918 in a Danish monograph. He confirms Lipschutz's observations of hypertrophy of the clitoris following iso-transplantation and gives a preliminary account of two cases of testis-implantation in castrated homosexual human males and of the successful regeneration of a 12½-year old dog by means of resection of the left epididymis and right-sided vasectomy. He is of the opinion that Leydig's cells are substantially the most important tissue in the production of the male sex-hormones. In the matter of ovarian grafts, he finds that the place of implantation and the relatedness of donor and host are factors of slight importance. One point of considerable interest emerges from his observations on the artificial hermaphrodite. Apparently mammary activity with milk secretion can be produced in a male organism in the entire absence of corpora lutea, uterus, and pregnancy.

VASECTOMY AND SIMILAR OPERATIONS.—In *Acta Chirurgica Skand.* (vol. 64, pp. 387-426, 1922) Sand gives an English edition of his paper in Danish (Ugeskrift for Laeger., 1922) dealing with the operation of vasectomy for regeneration. He prefers to free the epididymis and resect a portion under local anæsthesia. An account is given of thirteen patients treated for senium præcox and of five younger men treated for impotency, who have been under observation for 3-21 months. In the first group nine, in the second four, benefited by the operation. The rest were unsuitable cases. Sand adopts a very cautious attitude. In *Skand. Archiv f. Physiologie* (vol. 44, pp. 59-75, 1923) the same author describes the case of

a 10-year old individual, brought up as a boy, with imperfect external genitalia. An explorative operation was performed and a uterus and two Fallopian tubes were found. On the right side there was an infantile testis, on the left what appeared to be an embryonic ovary. The author discusses the question as to what gonadial tissue should be implanted and suggests that when puberty is reached indications will be forthcoming. In *Abhandlungen aus Handwörterbuch der Sexualwissenschaft* (Marcuss and Weber, Bonn, 1923) Sand deals with certain aspects of sexual physiology (such as sex-reversal, hermaphroditism, gonad transplantation, regeneration, cryptorchism, vaso-ligation) in which he is an authority, in a concise yet encyclopædic manner.

MOLLUSCA OF COLORADO.—Mr. J. Henderson's previous catalogue of the Mollusca of Colorado, published in 1907, being out-of-date and out of print, the author has compiled a fresh one (Univ. Colorado Studies, vol. xiii. No 2), extending the area treated so as to include the States of Utah, Montana, Idaho, and Wyoming, which appear to constitute a rather distinct molluscan province, characterised (except at its northern border) by the absence of Polygyra and by the presence of Oreohelix. The amount of work which a valuable compilation of this sort entails is well gauged by the bibliography and synonymies, whilst its utility is enhanced by the numerous illustrations in the text and on photographic plates. By the time a further edition is required, and we trust it may be soon, it is to be hoped Mr. Henderson will have seen his way to a more modern system of classification, for it has long ago been shown that Vallonia and Cochlicopa belong to the Pupillidæ, being Orthurethra and not Sigmurethra, whilst Succinea represents the Heterurethra; further, Dr. Sterki, whom he has followed for Pisidium, will have realised that two years before he announced the discovery in America of the *Pisidium parvulum* of Clessin, it had been shown to have no existence, being a composite of other and well-known species, whilst the form to which Dr. Sterki attaches that name is probably the *P. moitessierianum* of Pallary.

THE MECHANISM OF ADAPTATION.—Professor L. Diels of Berlin, writing in *Naturen* for July on how the shapes of plants are affected by climate, puts the difficulty of explaining the mechanism of adaptation very clearly. While adopting a cautious attitude, he concludes that "in one way or another there may be some truth in the ideas of Lamarck, though experiment has not yet enabled us to decide wherein that truth consists. Without the Lamarckian theory geographic adaptations in the organic world would be nothing but a puzzle." Prof. Diels recognises, no doubt, that a whole-hearted acceptance of the Lamarckian theory still leaves us to find the mechanism by which new somatic characters are transmitted to the germ.

PARAMO PLANTS OF THE COLOMBIAN ANDES.—The Philadelphia Academy of Natural Sciences has turned its Annual Report into a Year Book, but the change seems to be confined to the title. Both in the first of the new series and the last of the old a large part is taken up by attractively written and well-illustrated accounts of explorations and collecting trips conducted on behalf of the Academy. As an example may be chosen Dr. F. W. Pennell's narrative of a botanical expedition through the Andes of Western Colombia in 1922. The features of chief interest were the lofty wind-swept moors known as Paramos, where the plants protect themselves from the bitter blasts either by donning a woolly coat, by spreading prostrate along the ground, or by forming dense cushions of almost rock-like hardness. The most characteristic of the woolly plants are the "frailejones," usually species of Epeletia, one of which reaches a height of 10 ft. Each isolated region of paramo appears to have developed its peculiar "frailejones," and Dr. Pennell suggests that a knowledge of the relations of these species would greatly assist a reconstruction of recent geological history in the northern Andes.

SKULL OF DINOTHERIUM.—In the Memoirs of the Geological Survey of India (vol. vii. No. 4, 1924) has appeared an account, by the late Captain R. W. Palmer, of an incomplete skull of Dinotherium. Remains of this genus are usually so fragmentary that every account of new material is of value even if it does no more, as in the present instance, than confirm previous accounts. There is no editorial note to show when the manuscript was completed, but it is likely that the author's health, before his much to be lamented death in October 1922, prevented his seeing a paper by Andrews published in 1921 and one by Forster Cooper in 1922 on the subject of Dinotherium, both in the Proceedings of the Zoological Society. The specimen described is an incomplete fragment of a skull showing the basal surface from the condyles to the pterygoid region. The anatomical features shown do not differ markedly from those described by the late Dr. Andrews for the celebrated skull of *Dinotherium giganteum* in the British Museum, but the new specimen being in better condition, certain points are more clearly established. With regard to the question of the validity of the Indian species *D. indicum* and *D. pentapotamiæ*, the author concludes that they cannot be upheld and that they are both to be referred to the European form *D. giganteum*. This agrees with the views already published by Forster Cooper which were the outcome of a study of material from Baluchistan.

THE STRUCTURE OF LIGHT.—In the October issue of the *Philosophical Magazine*, Sir J. J. Thomson gives an account of a mental picture based on the idea of tubes of force which he has used for some time to reconcile the optical properties of light, which point to a wave theory, with the electrical properties, which demand some form of corpuscular theory. When an atomic electron falls towards its positive nucleus, the tube of force connecting them is not shortened, but forms a loop which may detach itself from the rest of the tube and move off as a free ring. Its emission is radiation, and the energy radiated is concentrated in the ring. Such a free ring may strike another tube and, in coalescing with the tube, lengthen it either temporarily or permanently. If the association is temporary only and the ring is thrown off, there is no absorption; if permanent, the electron has moved out from the nucleus and absorption has taken place. This picture is shown to be in keeping with the quantum theory and the principal facts of absorption and resonance.

THE HARDNESS OF SCATTERED X-RAYS.—An apparatus for measuring the hardness of X-rays, scattered through different angles, is described by Messrs. F. Dessauer and R. Herz in the *Zeitschrift für Physik* of August 28. Preliminary measurements have been made, in which the X-rays were filtered through 4 mm. of aluminium, so that they belonged to a narrow spectral region; they were sent in a narrow beam through holes, 5 mm. in diameter, in a series of concentric cylindrical lead screens, on to a sphere of paraffin placed at the axis of the cylinders. A series of holes in the lead cylinders allowed scattered beams, about 8 mm. in diameter, to pass outward at

...nles 30°, 60° . . . 150°, and fall upon a photo-...phic film, which was bent into a cylinder coaxial ...h the lead screens; the lower half of each beam ...ed through an aluminium filter. A movable ...d screen, with rectangular openings, made it ...sible to expose narrow vertical strips of the small ...ular patches formed on the photographic plate, ...o regularly increasing periods, 100, 200, 300 . . . ...utes, up to a total exposure of ten hours; thus ...h calibration of the photographic blackening, as a ...asure of the intensity of the radiation, can be ...le separately for each angle of scattering, *i.e.* for ...h wave-length. Since the whole series of observa-...ns is made simultaneously on the same photo-...phic plate, some of the possible errors are elimin-...d and others greatly reduced. It is possible to ...uce, from the photometric measurements of the ...ckening, the wave-lengths of the rays scattered at ...erent angles. The results obtained agree fairly ...l with those calculated by means of Debye's ...ory, thus confirming Compton's results. Measure-...nts in which monochromatic radiations are ...ployed are in progress.

The Geiger α- and β-Particle Counter.—Dr. H. Geiger discusses the working of the pointed electrode counter in the *Zeitschrift für Physik* of August 28. If the counter is 2 cm. in diameter, a β-particle produces primarily some 50 ions, or 2×10^{-8} electrostatic units; while, according to the voltage employed, the rush of electricity will be from 0·1 to ...limit. It seems clear then that an α- or β-particle ...uses a momentary discharge; but it is difficult to ...explain why this discharge breaks off so suddenly. H. Geiger has connected the point electrode to a ...sing electrometer, earthing them through a high ...sistance such that the time the charging rush lasts ...small compared with that which it takes to leak ...ay; if a capacity several times as large as that of ...e electrometer is then connected in parallel, the ...eflexions are reduced, and are roughly inversely ...proportional to the capacity, so that in each discharge ...e same quantity of electricity flows. It is not the ...e of voltage caused by the current rush which ...ops the discharge, for if this were the case the ...eflexion would be independent of the capacity. ...he point electrode in general requires a certain ...preparation before it will work properly; the form ...f the point and the degree of polish have little ...influence, but heating to incandescence will generally ...make the point active. Apparently the point be-...omes covered with a surface layer having a high ...electrical resistance; since platinum is a suitable ...material, this layer can scarcely consist of an oxide; ...he alteration seems rather to depend on the gas ...which covers the metal. Janitzky has shown that in ...n X-ray tube no discharge takes place from an ...electrode which has been perfectly freed from gas. ...n Geiger's theory, when a rush takes place, the ...outside layer of this surface film becomes charged, ...and the potential difference between this surface and ...he surrounding walls falls rapidly, so that the ...current stops soon after it commences.

A New Bleaching Reagent.—A new bleaching ...reagent for use in laundries is described by Dr. R. ...Seibelmann in the *Chemiker Zeitung* (1924, vol. 48, ...685) under the name of *activin*. This compound is ...the sodium derivative of *p*-toluene sulphochloramide, ...$CH_3 . C_6H_4 . SO_2 . NClNa + 3H_2O$, and belongs to the ...class of chloramines. Although the oxidising power ...of activin is due to "available" chlorine, it is much ...milder in its action than the hypochlorites though ...more effective than sodium perborate. Moreover, it ...possesses several advantages over the latter. Thus it is not easily decomposed by heat and it is not sensitive to the catalytic action of traces of copper and other metals, a property which is apt to render sodium perborate destructive to fabrics. It acts as a powerful germicide, being indeed comparable with corrosive sublimate in this respect.

Effect of Motion on Chemical Change.—The April-July volume of the *Compte rendu des Séances de la Société de Physique*, of Geneva, contains a paper by Duparc and Molly on the above subject. The authors examined the reaction between marble and a solution of ammonium chloride, both when the mixture was agitated, so that the pieces of solid rubbed against one another, and again when the liquid was merely circulated around the pieces of solid. It is claimed that the results were different in the two cases. In the first experiment the quantity of calcium carbonate dissolved increased to a maximum and then decreased, whilst in the second experiment a state of equilibrium was reached. It was shown that in the first case the solution contained free ammonia, and the reaction was assumed to occur according to the equation: $2CaCO_3 + 2NH_4Cl = CaCl_2 + Ca(HCO_3)_2 + 2NH_3$, whilst in the second case the reaction $CaCO_3 + 2NH_4Cl = CaCl_2 + (NH_4)_2CO_3$ attained a state of equilibrium.

The Delaware River Bridge.—This suspension bridge is in course of erection over the Delaware River between Philadelphia and Camden. The estimated amount of load which the cables will ever have to carry is nearly 60,000 tons, and requires two 30-in. diameter steel cables, each weighing nearly a ton per foot of length and each subjected to a maximum pull of 20,000 tons; there will be 18,000 wires in each cable. The design and construction of the anchorage for resisting these enormous forces is of particular interest, and an extremely lucid account will be found in the Journal of the Franklin Institute for September, where the design is treated by Mr. Allston Dana, of the Delaware River Bridge Joint Commission, and the construction by Mr. Montgomery B. Case, who is the senior resident engineer on the bridge. The anchorages are separated by a distance of about 0·6 mile, and will be concrete structures faced with granite, 218 ft. long, 190 ft. wide, 175 ft. above ground, and with foundations extending down to rock 65 ft. below ground in Philadelphia and 105 ft. below ground in Camden. Each anchorage will weigh 5 or 6 times as much as the pull exerted on it by the cables. The cables will enter the anchorage at points 130 ft. above ground and at an inclination of 8° with the horizontal; they will then bend over the top of an inclined steel tower and will pass down into the anchorage at an inclination of about 45°. Forty feet down each cable will be incased in a cast steel band the lower part of which is bell shaped, and the cable will then flare out in all directions, and will be looped round a group of 61 cast steel shoes connected to eyebars, which in turn will be connected to anchor girders placed as far down in the corner of the anchorage as practicable. The design of the anchorage structures introduces some very interesting calculations which are explained clearly by Mr. Dana. The caissons were sunk by dredging and their behaviour varied widely with the class of material under penetration. In sand and gravel the caissons followed the dredging gradually, whilst in clay or disintegrated rock they frequently held up until the excavation was 10 ft. or more below the cutting edge, when a sudden drop would occur and the cutting edge forced the material to the centre of the dredging. The paper is profusely illustrated with drawings and photographs, and we can recommend its perusal to all students of civil engineering.

Transmission of Stimuli in Plants.[1]

MR. R. SNOW has conferred a real benefit on botanists by reviewing Ricca's important experimental investigation on the conduction of stimuli in Mimosa, and by discussing the evidence for the conclusions of that Italian investigator which originated such an unexpectedly simple theory for the conduction of stimuli in plants. In the paper before us Mr. Snow describes how the experiments which Ricca performed on the conduction in the stem of *Mimosa spegazzinii* were repeated on *M. pudica*, and states that Ricca's explanation of the conduction, as depending on the transference of a hormone in the transpiration-current in the wood of the stem, has been tested and may be accepted as correct.

It will come, however, as a surprise to most physiologists that Mr. Snow does not consider this mechanism adequate to explain all the forms of conduction in *Mimosa pudica*. He believes that there are three types of transmission, namely, (1) The "normal" conduction in the transpiration-stream, elucidated by Ricca; (2) "high speed" conduction in the cambium or inner layers of the phloem, and (3) leaf-conduction in the phloem. Such a point of view demanding a special hypothesis to meet each type of conduction is not likely to find favour unless there is evidence to show conclusively that the original theory alone is unable to explain the experimental results. It may be stated at once that such evidence does not appear to be forthcoming.

First, with regard to the "high speed" conduction: This type is observed when a small lesion is inflicted on the inner layers of the phloem of the stem, or, occasionally, when an internode of the stem is cut through. In these cases the nearest one or two leaves above the cut are seen to fall practically simultaneously with the administration of the stimulus, while in "normal" conduction several seconds are required to traverse an internode. The reaction in the cases of "high speed" conduction also differs from that of "normal" conduction in that it involves only the main pulvinus and not the pinnules of the leaf. From the evidence, however, which Mr. Snow presents it does not seem probable that these two types differ essentially from one another. Assuming the liquid in the xylem is in tension, the rapidity of the motion of a hormone introduced into the xylem will depend on the relation of the cross-section of the conduit, in which the hormone moves, to the volume of the liquid moved by transpiration and by the elastic recovery of the tissues. Thus, if the motion upwards is confined to a slender linear series of tracheæ, the velocity will be high, while if a woody conduit having a large cross-section can be utilised, then the velocity will be small.

The method of experimentation described by Mr. Snow on p. 352 of his paper is just such as would produce a rupture of the tensile sap in one or two tracheæ and so allow the tensile liquid, having dragged in the hormone from the wounded cells, to hurry it upward in an instantaneously shortening filament of sap. The volume of this rising fluid is necessarily very small. Hence it is found able to affect only the pulvini of the reacting leaves and does not extend to the pinnules. Similarly it is evident that, where an internode is cut across, the velocity of the transfer of the hormone will depend upon the relation just pointed out. Consequently, the accident as to how exactly the cut is made, together with its chance relation to the transverse septa in the vessels, etc., will decide whether the conduction will be "high speed" or "normal." In this connexion Bode's observation should be borne in mind. He found that the tensile sap in tracheæ is ruptured by the pressure of a metallic point on the cells adjacent to the tracheæ. Thus we must infer that a rupture will take place in the sap just as the pressure of the blade producing the stimulus injures the semi-permeable protoplasm of the cells.

In the second place, Mr. Snow's reasons for assuming that the mechanism for the transmission of stimuli in leaves is fundamentally different from that in stems do not appear convincing. His first argument for this conclusion is that the rapid conduction observed in submerged leaves, or in those in a nearly saturated space, would be impossible if conduction depended solely on the movement of the transpiration-stream. It must be remembered, however, that, even in leaves in these conditions, there is evidence that tension exists, and that the turgescence (suction force) of the uninjured cells will draw liquid from the permeable injured cells back along the xylem. The very small cross-section of the xylem in the leaves will render the velocity of this motion comparatively great. Mr. Snow also believes that the fact, that in the leaf basipetal is as fast as acropetal conduction, shows that the conduction-mechanism of the leaf differs from that of the stem. This is just what we would expect if the hormone travels in the tensile sap; for the tension is hydrostatic and the resistance is the same in both directions.

Mr. Snow further finds support for his contention in Herbert's observation, that the velocity of conduction in the leaf is dependent on the intensity of the stimulus, while in the stem it is not so. Mr. Snow's own observations on "normal" and "high speed" conduction show that this rule is not without its exceptions. The fact that the volume of the tracheæ of the leaf is small compared with that of the stimulated cells furnishes a rational explanation of those cases where this difference is observed. This also accounts for the greater rapidity and greater certainty of the conduction in the leaf.

Again, the observation that an eosin solution is not always drawn back into the tracheæ of a responsive leaf cut under the stain, does not show, as Mr. Snow suggests, that in these cases there is no basipetal current in the tracheæ available for transport. Rather the failure of the stain to enter and pass down the xylem is almost certainly due to the unwettable surface of the leaf, which secures that the air adhering to the surface enters the tracheæ and prevents the eosin following the retreating sap. Mr. Snow himself instances a case where the eosin was drawn in 1·25 cm. in 60 seconds. In my own experiments I have observed a downward motion of the dye of 2·75 cm. in 40 seconds in the same circumstances. Lastly, in Mr. Snow's experiments, where transmission was observed in leaves after the continuity of the xylem had been broken by a cut not involving the phloem, there is no evidence produced that the hormone did not pass in the liquid filling the cut. Such transference has been shown to take place in stems and it is hard to see why it should not do so in leaves.

With regard to the nature of the hormone responsible for evoking the reactions, Mr. Snow has made some interesting observations. The hormone may be rendered inactive by dilution, and probably by boiling. Ricca found that of *M. spegazzinii* was not thermolabile. It is not precipitated by a protein-precipitant. It diffuses through a collodion shell. It is not injured by desiccation, nor by treatment by strong alcohol.

HENRY H. DIXON.

[1] R. Snow, "Conduction of Excitation in Stem and Leaf of *Mimosa pudica*," Proc. R.S., Series B, vol. 96, No. B 678.

The Scattering of X-rays.

N exceptionally successful session of Section A the British Association at Toronto this year, s no discussion created such widespread interest which centred round the papers of Prof. A. H. on of Chicago, and Prof. Duane of Harvard, on attering of X-rays. The subject is one which d considerable influence on the development of n physical theory. It was as a result of the of scattering advanced by Sir J. J. Thomson arkla was able to deduce from his experiments he number of electrons in the atom was approxi- equal to one-half of its atomic weight, a result ined by other methods some years afterwards oseley. Later developments indicated that the menon of scattering was more complex than son's theory assumed. The work of various ers on γ-rays showed that the absorption of rays was greater after scattering than before, which suggested that during the scattering was a shift in the wave-length towards the long length end of the spectrum. Similar results had obtained with X-rays. Recent developments of technique have made it possible to carry out ments of a much higher order of accuracy and placed at the disposal of the physicist powerful s of monochromatic radiation. It was natural, ore, to expect that the problem would be ked anew, and this has been done by several vers, notably Compton and Duane.

mpton's work was undertaken primarily to test ruth of a theory advanced independently by lf and by Prof. Debye of Zurich. The theory is eat interest, and a brief sketch may be given. eas the original theory proposed by Thomson based on classical electromagnetic conceptions, of Compton and Debye is founded on the um theory. In the simplest case a quantum of tion of frequency ν falls on the scattering sub- e, and may be considered as colliding with an on which is either free or very loosely bound to om. This electron takes up some of the energy e quantum, and the radiation passes on as a tum of somewhat lower frequency. The re- der of the energy appears as kinetic energy of electron. It is assumed that, during the en- ter between the radiation and the electron, the of conservation of energy and momentum are ed. The energy of the quantum is $h\nu$ and its entum is taken as $h\nu/c$, where c is the velocity of h. If the equations representing the conservation ergy and momentum are solved, it is found that change in wave-length of the radiation scattered direction making an angle θ with the original n is given by $h/mc(1-\cos\theta)$ or $0{\cdot}024(1-\cos\theta)$ Å.

this theory is correct, and we allow a beam of chromatic X-rays to fall on a scattering sub- ce and analyse the radiation scattered at an e θ, we should expect an increase in wave-length $0{\cdot}024(1-\cos\theta)$. Such a change is well within the e of measurement of modern X-ray spectroscopy. pton conducted a series of experiments on these s, and found that in the scattered radiation two e-lengths predominated, one being identical with, other longer than, that of the unscattered beam. difference in wave-length was found to agree itin experimental error with that predicted by the ery. Again, the separation of the two depended he angle of scattering in just such a manner as cipated by the theory. Further, a series of rption experiments yielded results consistent his hypothesis, and, finally, a study of C. T. R. Wilson's track photographs revealed the existence of electrons with the energy and direction of motion to be expected.

Further confirmation of the Debye-Compton theory came from independent observers, notably Profs. Ross and Bergen Davis. Ross used a photographic method instead of the ionisation apparatus employed by Compton. He found two lines on his plates, one corresponding to the wave-length of the original beam, the other to a radiation of longer wave-length. The separation increased with the angle of scattering as in Compton's experiments.

Had it not been for the experimental work of Duane, there is little doubt that these results would have been generally accepted as affording strong evidence in favour of the theory, if not as entirely establishing it. For the past year or two, however, Duane and his research school have been engaged on a series of experiments on the radiation emitted from various substances when bombarded by X-rays. They find, in addition to radiations identical with the primary beam, other radiations of longer wave-length. Their measurements indicate that these can be explained as due to the photoelectrons ejected from the matter by the primary radiation. It requires a certain amount of energy to eject an electron from its parent atom, the amount depending on the energy level from which it has to be removed. The kinetic energy of the electron will be less by this amount than the energy corresponding to a quantum of the X-radiation. If, in their turn, these electrons strike other atoms of the scattering substance, they will give rise to X-rays the maximum frequency of which will correspond to their kinetic energy in accordance with the Einstein equation $\frac{1}{2}mv^2 = h\nu$.

Duane finds that his experiments are consistent with such an explanation. It is clear that, on this theory, different substances will give rise to different radiations according to the energy required to remove an electron from the matter. On the Compton-Debye theory the wave-length of the softer radiation is independent of the nature of the scattering substance. In the case of carbon bombarded by the K radiation of molybdenum—the rays used by Compton —the chief effect observed by Duane nearly coincides with the Compton effect, but for heavier atoms the two theories give rise to radiations of different wave-lengths. Duane found that, with his apparatus, he was unable to find evidence for the existence of the effects observed by Compton, Compton, on the other hand, could not repeat satisfactorily Duane's experiments. A matter of such importance could not be left in such a position. Each observer investigated the apparatus used by the other and convinced himself of its trustworthiness. Duane observed that the only obvious difference in the experimental arrangements was that Compton's X-ray tube was enclosed in a wooden box covered with lead, while his own tube was not so enclosed, the tube being in one room and the rest of the apparatus in the adjoining room. Improbable as it appeared that such a difference could account for the difference in the experimental results, Duane tried the effect of such a box and found to his surprise that, in addition to the effects he had previously observed, a new peak appeared in approximately the position observed by Compton. The exact position of this effect depended on the orientation of the box. At the time of the Toronto meeting this represented the state of affairs.

In the general discussion various other members took part. Prof. Webster gave a detailed description of the experimental arrangements used by Ross, and

contended that the box in which Ross's tube was enclosed could not possibly account for the results he obtained. Prof. Gray described experiments on γ-rays and showed that they were consistent with the Compton theory. Prof. Raman made an eloquent appeal against a too hasty abandonment of the classical theory of scattering. Compton sketched an extension of his theory in which he considered not only free electrons but also those which were more tightly bound. He showed that the extended theory gave rise in the limiting case to the formula used by Duane and therefore embraced Duane's results. The fundamental difference between the two theories remains; Duane uses only the well-established quantum energy equation, while Compton in addition introduces the idea of conservation of momentum in the interaction between the radiation and matter. There are difficulties in the way of both theories, but at the present stage of the experimental work it is needless to dwell upon them. Before the theoretical side of the question can be satisfactorily discussed, further experimental work must be done. At the time of the meeting each observer appeared to have almost overwhelming evidence in favour of his point of view, and had the audience only had to listen to one side—either side would have done equally well—it would probably have been convinced as to the accuracy and soundness of the views advanced. As it was, however, the average member left the meeting inclined to echo the sentiments of the lover in the "Beggar's Opera" who sings

"How happy could I be with either,
Were t'other dear charmer away!"

The Spectrohelioscope.[1]

By Prof. GEORGE E. HALE, For. Mem. R.S.

MONOCHROMATIC images of the sun, photographically recorded with the spectroheliograph, reveal the phenomena of the solar atmosphere in projection against the disk. The light from a spectral line of calcium, hydrogen, or other substance is singled out by a narrow second slit, which moves across the plate while the first slit moves across the solar image. A monochromatic picture is thus built up of countless narrow slit images, recorded side by side in slow succession.

The vortices and other significant structures thus disclosed, with the exception of an occasional brilliant eruption or unusually dark hydrogen flocculus, are beyond the reach of visual observation with the spectroscope. The simple method of opening the slit, which affords an excellent view of prominences at the sun's limb, because the light of the sky is sufficiently weakened by dispersion, is seriously limited when applied to the intensely brilliant disk. Even with the highest dispersion the slit cannot be opened sufficiently to reveal the characteristic structure of the dark hydrogen flocculi. Moreover, with a widened slit the image is not strictly monochromatic.

This simple expedient of rapidly oscillating the narrow spectroscope slit, and synchronously with it a second slit transmitting the Hα line to the eye, was tried by the earliest observers of the prominences. With suitable precautions this device gives excellent images of prominences through persistence of vision, but it did not survive the introduction by Zoellner and Huggins of the wide slit method, and apparently was not tried for observing the sun's disk.

Many years ago I made some preliminary trials of the oscillating slit method with the 30-foot spectroscope and 60-foot tower telescope on Mount Wilson. I have only recently found opportunity to develop a satisfactory instrument based on this principle with which I have now secured good visual observations of both bright and dark flocculi.

An image of the sun two inches in diameter, given by a cœlostat and a 12-inch objective formerly belonging to the Kenwood Observatory,[2] was observed with a grating spectroscope mounted horizontally. In this instrument the light passing through the slit falls on a 6-inch concave mirror of 13-feet focal length, which returns a parallel beam to a point just below the slit, where a 6-inch plane grating is mounted. This sends the diffracted beam to a second 6-inch concave mirror, supported below the collimating mirror, which forms an image of the spectrum in the same plane as the first slit, and immediately below it. A fixed second slit at this point permits any part of the spectrum to be isolated. The grating was ruled by Jacomini with about 15,000 lines to the inch on the ruling machine of the Mount Wilson Observatory, with a diamond ground after Anderson's formula so as to give great brightness at the red end of the first order spectrum. The definition is perfect, and the brightness near Hα remarkable, as the attempt to concentrate most of the light in one spectrum and to favour the red end proved successful.

Suppose the first and second slits to be carried at opposite ends of a brass bar, mounted on a bearing half-way between them and thus free to revolve about this centre. Place the bar vertical, and turn the grating until the Hα line in the bright first order is bisected by the second slit. With the optical arrangement employed, a small displacement of the first slit to the right causes an exactly equal displacement of the Hα line to the left. Thus if the bar is oscillated back and forth by means of a small electric motor, a monochromatic image of the sun will be seen through a low power positive eyepiece focussed on the second slit.

This arrangement serves very well for the observation of prominences at the limb, where they can be seen at their full height with slits of moderate width. It also shows exceptionally bright or dark flocculi on the disk, though the slits must be narrower in order to give sufficient purity and reduce the brightness of the continuous spectrum. For flocculi of ordinary intensity the best results have been obtained with the aid of multiple slits, five at each end of the bar, 0·003 inch wide and 0·08 inch apart. A fixed slit, slightly less than 0·08 inch wide, must be used behind the upper slits, to prevent the formation of overlapping spectra. Two complete oscillations of the bar per second, corresponding to twenty illuminations of the retina, give a sufficiently steady image. A rotating disk, carrying a large number of radial slits, is in some respects a more satisfactory device for the same purpose.

This instrument, which may appropriately be called a spectrohelioscope, should prove a valuable auxiliary of the spectroheliograph in several kinds of work. It will permit the rapidly changing forms of eruptions on the disk to be followed visually, and be of special service in deciphering the curious differences of structure sometimes found on photographs of flocculi taken simultaneously with the opposite edges of Hα. As the oscillating bar can be moved toward red or violet by a micrometer screw while observations are being made, the possibility of passing instantly from one edge of the line to the other should assist in the interpretation of the spectroheliograph results.

[1] Communicated to the National Academy of Sciences, Washington, on July 7, and published in the Proceedings of the Academy for August, vol. 10, No. 8, 1924.

[2] Kindly loaned me by Prof. Frost. The apparatus was set up temporarily in my garden at South Pasadena.

Oil-Cracking.

A PAPER on "Recent Development in the Art of Cracking," by A. E. Dunstan and R. Pilkethley, was read before the Institution of Petroleum Technologists on October 7. The object of "cracking" is to change in a lighter constituent from hydrocarbon oils by temperature treatment, under suitable conditions. During the last few years there has been little advance in our knowledge of cracking from the chemical point of view, and most of the problems connected with it have been more of an engineering quality. Very little work has been done on the examination of the residues left after the cracked gasoline has been removed from the synthetic crude oil.

Vapour phase processes working at atmospheric pressure have not been very successful; most of the processes developed worked under 300 to 400 lb. per sq. in. pressure, and no particular advantage in the use of extremely high pressures is apparent. The Bergius process was at first directed towards the production of artificial coal from wood, cellulose, etc., and a black powder containing 84 per cent. of carbon was obtained at 349° under 160 atm. pressure. This was susceptible of hydrogenation by heating to 400° in the presence of hydrogen for some hours, and over 90 per cent. of the product was soluble in benzene. Later experiments, natural coal mixed with oil was converted up to a 90 per cent. yield of oil, yielding fractions suitable for use as fuel oil.

The experiments of the present authors throw some doubt on the hydrogenation of the liquid products. Processes for cracking in the vapour phase, *e.g.* the Winnage plant, in which the vapour of the hydrocarbon is passed over heated iron oxide, were described. The Dubbs process is two-stage, the oil being cracked in tubes in the liquid state, then passed to a reaction chamber where carbon is deposited, and the vapours then passed to a dephlegmator which separates heavy oil from lighter cracked vapours. The pressure is about 150 lb. per sq. in., and the process is commercially successful. The Cross process differs from the Dubbs process in the form of the apparatus, and the pressure and temperature conditions.

The Auld, Dunstan and Hering process is described. It is substantially a liquid phase operation throughout, the pressure being sufficiently high to maintain all but the lightest products liquid (25-30 atm.); the yield of light spirit is restricted for definite reasons, the temperature range is definitely fixed for each oil, and the rate of flow is controlled according to the temperature. The oil is first carefully heated to know the optimum temperature, quickly raised above this temperature, and then allowed a certain time of contact in a reaction vessel, where carbon is deposited. The cracked oil is drawn off from the highest point of the vessel, condensed or dephlegmated, and discharged into a gas separator. Experimental plant recently used is also described, and the important problem of refining, including distillation over bauxite or activated carbon, is discussed.

University and Educational Intelligence.

CAMBRIDGE.—Mrs. Marshall, widow of the late Prof. Alfred Marshall, has offered to the university a most valuable selection of books from her husband's library for the use of students in economics, together with 1000*l.* to be used in expenses connected with the books and with any arrangements which may be made for facilitating economic research.

Dr. Dollo has been appointed to represent the University at the fiftieth anniversary of the founding of the École Polytechnique of the University of Brussels. Prof. A. C. Seward has been appointed as a Trustee of the Percy Sladen Memorial Fund. Mr. T. A. Carroll, Sidney Sussex College, has been appointed assistant director of the Solar Physics Observatory in succession to Mr. E. A. Milne, who has resigned on being appointed to the Beyer chair of applied mathematics at the University of Manchester.

At Emmanuel College the following have been elected to Research Studentships: G. A. Reay, University of Aberdeen (biochemistry); W. W. Grave (Romance literature); and P. A. Taylor (mathematics).

CORK.—Applications are invited for the professorship of chemistry at University College. Particulars are to be had from the secretary.

LONDON.—Birkbeck College, which celebrated its centenary last year, announces in its calendar for 1924–25 that great development in accommodation and in facilities for study in the college is probable in the near future. Appended to the calendar is an imposing list of original publications by members of the staff and students, chiefly in chemistry, physics, zoology, geology, classics, and modern languages.

Prof. S. L. Loney has been elected chairman of Convocation, and Sir Josiah Stamp representative on the Senate of the Registered Graduates in Science.

DR. A. T. DE MOUILPIED, of the British Dyestuffs Corporation, has been appointed professor of science at the Royal Military Academy, Woolwich, in succession to Prof. J. Young, as from January 29 next.

APPLICATIONS are invited for the headship of the chemical department of the Midland Agricultural and Dairy College, Sutton Bonington, Loughborough. Particulars of the appointment may be had from the principal.

A LECTURER in agricultural chemistry is required at the Cheshire School of Agriculture, Reaseheath, Nantwich. Applications, upon a prescribed form, must be sent to reach the principal of the school by November 7 at latest.

DR. ALEX HILL, secretary of the Universities Bureau of the British Empire, 50 Russell Square, London, W.C.1, informs us that the six great lines engaged in the passenger service to Australia and New Zealand have agreed to grant eight free first-class return tickets, yearly, to University graduates desirous of studying problems connected with the development of the resources of the Dominions, or of holding temporary teaching posts. The selection of the recipients is to rest with a committee of the Universities Bureau.

THE Senate of the University of Sydney has resolved on the appointment of a chief executive paid officer, with the title of Vice-Chancellor, to take the place of the Warden and Registrar, Mr. H. E. Barff, who has just retired. The necessary legislation is being drafted, and in the meanwhile Prof. MacCallum has been asked to undertake the duties of Warden temporarily. Prof. J. I. Hunter and Dr. N. D. Royle have been invited to deliver the Doctor John B. Murphy oration in surgery at the meeting of the American College of Surgeons to be held in New York on October 20.

THE following candidates have been nominated for election as Parliamentary representatives of the universities of Great Britain and Northern Ireland:—CAMBRIDGE (2)—Mr. James Butler (Ind.), Sir Geoffrey Butler (U.), and Mr. J. F. P. Rawlinson (U.). LONDON (1)—Sir John Rose Bradford (U.), Dr. F. G. Bushnell (Lab.), Dr. E. G. Graham Little (Ind.), and Prof. A. F. Pollard (Lib.). OXFORD (2)—Lord Hugh Cecil

(U.), Prof. Gilbert Murray (Ind.), Sir Charles Oman (U.). SCOTLAND (3)—Sir George Berry (U.), Mr. D. M. Cowan (L.), Sir Henry Craik (U.), Rev. J. M. Munro (Lab.). WALES (1)—Mr. G. M. L. Davies (Lab.), Capt. E. Evans (L.). QUEEN'S, BELFAST (1) —Col. T. Sinclair (U.).

THE Municipal College of Technology, Manchester, announces reductions in fees for degree and certificate courses amounting to 10 per cent. in favour of residents in Lancashire and Cheshire (who were already favoured to the extent of 16 per cent.), and 16 per cent. in favour of students from other parts of the British Empire. According to the Calendar for 1924–25, courses of post-graduation and specialised study and research are offered in mechanical engineering (including hydraulic experimental work, motor-car engineering, and eight other subjects), electrical engineering, municipal and sanitary engineering, applied chemistry (including textile fibres, paper manufacture, metallurgy, india-rubber, brewing, coal-tar and dyestuffs, and photography), textile industries, applied physics, and mining engineering. Last year, ten research scholarships of 100*l*. each were awarded by the College. Among other technical college calendars recently received are those of Loughborough College (departments of mechanical, civil, electrical, automobile, and commercial engineering, pure and applied sciences including chemical technology, extra-mural adult education, and school of industrial and fine art) and the Battersea Polytechnic (engineering, pure and applied mathematics, physics, chemistry and technological chemistry, photography, hygiene and public health, domestic science, and arts and crafts). The subjects of the Polytechnic's technological courses include oil industries, paper industries, and flour-milling.

THE Vice-Chancellor of Oxford has contributed to the October number of the *Empire Review* an article on "Oxford and the Empire." Starting with the great Elizabethans, Sir Humphrey Gilbert of Christ Church, his half-brother Sir Walter Raleigh of Oriel College, and Richard Hakluyt of Christ Church, he gives a list of Oxford men who have during the last four hundred years played distinguished parts in building up the British Empire or the ideas on which it is based, or in its governance. He points out that of the twenty-five governors-general of India from Warren Hastings to Lord Curzon, fourteen were university men; and of these, twelve were educated at Oxford, nine of them at Christ Church. He discusses the features of university life which favour the development of those qualities which go to make good administrators, and deplores the fact that the Indian Civil Service no longer attracts Oxford graduates. Of the Rhodes scholars, he singles out for mention the late Sydney Fairbanks of Rhodesia, who chose an Oxford career especially with the view of developing his own plans of child emigration. The influence on Oxford of Rhodes scholars from the overseas Dominions and the influence of their Oxford training on their subsequent careers is a theme deserving more attention than it has hitherto received. It is to be hoped that the Vice-Chancellor's article may lead to studies of this theme and also of the relations between other universities and the Empire. As Prof. Newton says in his new book, "The Universities and Educational Systems of the Empire," every university is, in a sense, imperial, but the peculiarly imperial university is one that by long prescription, by eminent advantages of situation, and by the labours of a line of great investigators, has acquired prestige and reputation as a *studium generale*.

Early Science at the Royal Society.

October 27, 1670. There was read a Latin letter from Signor Montanari of Bologna, expressing the singular esteem which he had of their institution. —Mr. Oldenburg produced another Latin letter from Erasmus Bartholinus, M.D. of Copenhagen, giving notice of a certain transparent stone, a kind of selenites, sent out of Iceland, and having different positions, a double, quadruple, and sextupline refraction; as also an electric virtue.

October 28, 1663. At a meeting of the Society the president reported to them, that because the stationers and printers are of one and the same company, and may, by the concession of both sides, practise both trades promiscuously, the Society might choose a stationer for their printer without violation to their charter, which gives them power to choose printers. Whereupon Mr. John Martyn and Mr. James Allestry being recommended, it was put to the question, whether it should be the question, that the office of printer to the Royal Society should be conferred jointly; and it was carried in the affirmative; after which those two persons were put to the ballot, and chosen.

1669. Mr. Oldenburg mentioned that Dr. Wren desired to borrow that engine of his, in order to make a scheme and description thereof for the satisfaction of Mons. Huygens, who, though he had much applauded that invention, and the demonstration of it, yet had made some objection against its practicableness.

October 29, 1662. Dr. Wilkins and Dr. Goddard gave an account of the experiment which had been made of a lamp burning under water in a vessel of four gallons, the ellychnium being one single thread of cotton, and the lamp wholly under water: the flame lasted eleven minutes.—They were desired to repeat the experiment several times; as also to try it with some live creatures.

October 30, 1672. An account being demanded of what trials had been made for the improvement of the reflecting telescope of Mr. Newton, Mr. Hooke said, that hitherto he had wanted a mould of a sufficient bigness for a speculum, designed by him of fifteen inches diameter, for a tube of ten feet long; but that he hoped to have, soon, such a mould cast, wherein a speculum of that bigness might be well wrought and polished.

1674. The form of the summons to the Society for returning to their weekly meetings being read again, it was thought fit to omit the names of the persons who were to entertain the Society, and to let it be as follows:—these are to give notice that the Royal Society intends to return to their public meetings on Thursday, being the 12th of this instant November 1674, in Gresham College; at three of the clock; at which time and the following days of their meetings the company will be entertained with experimental exercises, to be performed by several eminent members of the same, in order to a more vigorous prosecution of the ends of their institution.

October 31, 1667. Mr. Evelyn presented the Society with his wooden tables, having the veins and arteries of the human body fixed on them.—A report being made of Dr. Allen's scrupling to try the experiment of transfusion upon any of the mad people in Bethlem-hospital, it was ordered that he should be desired by Mr. Hooke to give a meeting at Sir George Ent's house on the Monday following to some of the physicians of the Society, as Sir Theodore de Vaux, Dr. Clarke, Dr. Lower, Dr. Balle, and Dr. King to consider together, how this experiment might be most conveniently and safely tried.

Societies and Academies.

LONDON.

Optical Society, October 9.—E. T. **Hanson**: Some problems in the theory of optical diffraction. A semi-infinite plane may be looked upon as a wedge the internal angle of which is zero. The application of Kirchoff's formula in the latter case is considerably extended, it being shown that, through a region of not too small dimensions comprising the whole of the boundary of the geometrical shadow, the solution obtained is identical with the accurate solution. An expression is found for a plane wave incident at any angle upon a semi-infinite screen. An approximate expression is also found for the disturbance distributed over a straight slit due to a wave incident obliquely. Kirchoff's formula has been applied, apparently for the first time, to an area of disturbance which is non-uniform.—W. M. **Hampton**: The annealing and re-annealing of glass. Relations connecting the strains present when cooling commences, strain applied to gradient, and strain present after cooling, are obtained and the equations are applied to the case of slabs. The considerations affecting the temperature and conditions of annealing are discussed and rules giving annealing temperature, annealing time and rate of cooling for various kinds of glass are included.

PARIS.

Academy of Sciences, September 22.—M. A. Laisonval in the chair.—Paul **Appell**: The order of a non-holonomial system.—E. **Mathias**: The theory of the lightning flash.—Georges J. **Rémoundos**: Couples of functions of one variable corresponding to the points of an algebraic curve of genus higher than unity and on a generalisation of a theorem of M. Picard.—Benjamin **Jekhowsky**: The elements of the planet Algiers M = 1924 PQ.—E. M. **Antoniadi**: The retarded decrease of the southern snows of Mars and its coincidence with the solar minimum.—E. **Brylinski**: On a possible thermal perturbation in Michelson's experiment.—Nicolas **Perrakis**: A remarkable property of the first differential of the Trouton-de Forcrand law and on the probable value of the electronic entropy.—T. **Batuecas**: Revision of the compressibility of methyl oxide and the molecular weight of this gas. The pressures exerted by a given mass of methyl ether were measured at five volumes, the results being expressed in the form $pv = a - bp$. From the density of the normal litre previously determined and the coefficient obtained from these experiments, the figure 11·999 is deduced for the atomic weight of carbon. This result proves that the law of limiting densities is rigorously applicable in all cases, provided that the variation of the compressibility with the pressure is taken into account.—L. **Locoste**: Microseismic movements at Strasbourg. It is shown that there is a relation between the microseismic movements and meteorological conditions (variations of barometer and of wind velocity).—Alfred **Carpentier**: The fructifications of the Pteridospermeæ from the Westphalian of the North of France.—**Bezssonoff**: The colour reactions of the liposoluble factors. A study of the colour reactions produced with phosphomolybdotungstic acid.—F. **Vincens**: Possibility of the transmission of pernicious *loque* of bees by the grubs of *Galleria mellonella*.—E. **Lesné**, R. **Turpin**, and Ch. O. **Guillaumin**: Some physico-chemical variations of the plasma during conditions favouring convulsions in the child.—Marc **Romieu**: Microchemical studies on the granulations of the eosin-fixing leucocytes in man.

ROME.

Royal Academy of the Lincei; papers submitted during the Vacation, 1924.—G. **Ricci-Curbastro**: Varieties in equal principal invariants.—M. **La Rosa**: The Doppler effect and the ballistic principle in relation to the velocity of light. A reply to a note by W. De Sitter.—A. **Angeli**: Constitution of santonin. The compounds resulting from the gradual decomposition of santonin by means of dilute aqueous permanganate are described.—Ferruccio **Zambonini**: Atomic structure according to Bohr, and the isomorphogenism of metals of the rare earths with those of the calcium group.—Giuseppe **De Lorenzo**: Coal in the mesozoic strata of Lagonegro in Basilicata.—P. Vinassa **de Regny**: The mesozoic region of Central Dancalia.—Francesco **Tricomi**: Numerical resolution of Fredholm's integral equations.—O. **Mayer**: Transformations between linear elements of two surfaces which retain Levi-Civita's parallelism.—G. **Cassinis**: Gravimetric comparison of Rome with Bologna and Padua. If the value of g is taken as 980·367 cm. at Rome, the corresponding values at the University of Bologna and at the Royal Astronomical Observatory at Padua are respectively 980·455 and 980·659 cm.—Franco **Rasetti**: Effect of the magnetic field on the polarisation of resonance radiation. The results of experiments with mercury vapour are described, and the known facts are shown to be capable of simple correlation and to be intimately connected with the Zeeman effect and with the orientation of the atoms in the magnetic field.—A. **Cruto**: Chemical constitution of insulin. The empirical formula of highly purified insulin confirms the classification of this substance with the proteins, and, in conjunction with its reactions, indicates for it a position among either the globulins or the albumoses.—G. **Mazzetti**: Thermal dissociation of certain carbonates. The means adopted in the study of these dissociations consisted of thermal analysis and of an arrangement permitting the curve connecting the temperature with the diminution in weight to be traced directly on a photographic plate. Certain of the values obtained for the temperature of initial decomposition differ from those given by previous investigators.—V. **Tognazzi**: Chalkones and hydrochalkones. In alcoholic solution and in the presence of platinum black, each of the chalkones examined absorbs two atoms of hydrogen, yielding the hydrochalkone.—Carlo **Cappelletti**: The vegetation of resins. The fungi found in resins are nourished by the impurities always extruded with the resins and are able to tolerate oil of turpentine in relatively high proportions. In a moist climate the slow drying of the resin encourages the establishment of the fungoid vegetation, whereas in a dry climate the resin undergoes rapid superficial drying, invasion of the mycelia being thus checked.—P. **Pasquini**: Further knowledge of the pelagic fauna of Lake Trasimeno.—U. **Pierantoni**: New observations on luminescence and symbiosis. III. The luminous organ of *Heteroteuthis dispar*.—M. **Sella**: Observations on the innervation of the myotome of the murenoids and other Teleostei.

CAPE TOWN.

Royal Society of South Africa, August 20.—Dr. A. Ogg, president, in the chair.—S. H. **Haughton**: A bibliographic list of pre-Stormberg Karoo reptilia with a table of horizons.—G. W. **Cox**: On the periodicity of rainfall. A cursory inspection of any table of annual rainfall values discloses irregularities which suggest the results of pure chance. A vital question in long range weather forecasting is whether the values of data follow any law of succession separable from the law of chance. This paper discusses the existence of a cycle in rainfall.

Official Publications Received.

Bureau of Education, India. Pamphlet No. 18: Conference of Indian Universities held in May 1924 at Simla. Pp. viii+79. (Calcutta: Central Publication Branch.) 7 annas; 8*d*.

Agricultural Research Institute, Pusa. Bulletin No. 154: The Bionomics of the Sarcoptic Mange Parasite of the Buffalo, with some Observations concerning the relative Power of Resistance to Adverse Conditions of the different stages of the Acarus and of its Egg. By T. M. Timoney. Pp. 180-200. (Calcutta: Central Publication Branch.) 2 annas.

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, No. 25: Size in relation to Internal Morphology. No. 1: Distribution of the Xylem in the Vascular System of Psilotum, Tmesipteris, and Lycopodium. By Claude W. Wardlaw. Pp. 503-532. 4*s*. Vol. 53, Part 3, No. 23: Observations on the Early Development of the Human Embryo. By Prof. Thomas H. Bryce. Pp. 533-567+9 plates. 7*s*. 6*d*. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Travaux du Laboratoire de Psychologie expérimentale de l'Université de Cracovie. Édités par W. Heinrich. Pp. iv+391. (Cracovie: Académie Polonaise des Sciences et de Lettres; Paris: Félix Alcan.) 25 francs.

Memoirs of the Indian Museum. Vol. 5: Fauna of the Chilka Lake. No. 12: Crustacea Copepoda, by Major R. B. Seymour Sewell; Mollusca Gastropoda (revision) by the late Dr. N. Annandale; Tanaidacea and Isopoda, by Prof. Charles Chilton. Pp. 771-896+plates 44-60. (Calcutta: Zoological Survey of India.) 10 rupees.

Report of the Aeronautical Research Institute, Tōkyō Imperial University. No. 7: Über die Mechanismen der Zyklonen und Antizyklonen. Von Tatuo Kobayasi. Pp. 187-212. (Tōkyō: Maruzen Kabushiki-Kaisha.) 0.700 Yen.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 52: The Effect of the Summer Fallow upon Soil Protozoa in Egypt. By Dr. E. McKenzie Taylor and A. Chamley Burns. Pp. 10. (Cairo: Government Press.) 5 P.T.

Bulletin of the American Museum of Natural History. Vol. 51, Art. 5: Basin Structures in Mongolia. By Charles P. Berkey and Frederick K. Morris. Pp. 103-127. (New York.)

Proceedings of the Cambridge Philosophical Society. Vol. 22, Part 3. September 20th. Pp. 201-480. (Cambridge: At the University Press.) 10*s*. net.

Report of Technical Conference held under the Auspices of the Rubber Growers' Association, Inc., and the Research Association of British Rubber and Tyre Manufacturers, London, Friday, 18th July 1924. Pp. 44. (Croydon: Research Association of British Rubber and Tyre Manufacturers, 105 Lansdowne Road.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1425: The Tobacco Flea-Beetle in the dark Fire-cured Tobacco District of Kentucky and Tennessee. By A. C. Morgan and J. U. Gilmore. Pp. 12. (Washington: Government Printing Office.) 5 cents.

Koninklijk Nederlandsch Meteorologisch Instituut. No. 102, Mededeelingen en Verhandelingen. 23: De Stoomwegen van Ceylon naar de Golf van Aden in den Zuidwestmoesson. By P. M. Van Riel. Pp. 20. 0.35 fl. 29a: Klimatologie van den Indischen Ocean. (With English Summaries.) By P. H. Gallé. Pp. 87. 1.50 fl. (s-Gravenhage: Algemeene Landsdrukkerij.)

Koninklijk Nederlandsch Meteorologisch Instituut. No. 108. Seismische Registrierungen in De Bilt. 9, 1921. Pp. xiv+44. (Utrecht: Kemink en Zoon.) 0.80 fl.

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 4: A Type Rural High School—Mount Vernon Union High School, Skagit County, Washington. By C. A. Nelson and E. E. Windes. Pp. iii+36. Bulletin, 1924, No. 23: Government Publications useful to Teachers. Compiled by Eustace E. Windes. Pp. 34. (Washington: Government Printing Office.) 10 cents each.

British Museum (Natural History). British Butterflies. Series No. 2, Set E19. 5 cards in colour. Series No. 3, Set E20. 5 cards in colour. Series No. 4, Set E21. 5 cards in colour. Series No. 5, Set E22. 5 cards in colour. Series No. 6, Set E23. 5 cards in colour. Series No. 7, Set E24. 5 cards in colour. Exotic Moths. Series No. 4, Set E25. 5 cards in colour. Series No. 5, Set E26. 5 cards in colour. Series No. 6, Set E27. 5 cards in colour. British Moths. Series No. 2, Set E28. 5 cards in colour. (London: British Museum (Natural History).) 1*s*. each set.

Canada. Department of Mines: Geological Survey. Summary Report, 1923, Part A. Pp. 114A. Memoir 139, No. 119 Geological Series: Coquihalla Area, British Columbia. By C. E. Cairnes. Pp. 187. (Ottawa: F. A. Acland.)

Diary of Societies.

MONDAY, OCTOBER 27.

CAMBRIDGE PHILOSOPHICAL SOCIETY (Annual General Meeting), at 4.30.—J. T. Saunders: The Hydrogen in Concentration of the Waters of Lake Lucerne.—J. Gray: The Process of Cell Division in the Eggs of Echinoderms.—V. Nath: Oogenesis of Lithobius.—*By title only*:—Dr. H. Singh Pruthi: Studies on Insect Metamorphosis—1. Prothetely in Mealworms (*Tenebrio molitor*) and other Insects. Effects of Different Temperatures.—H. Munro Fox: Chlorocruorin.—C. G. F. James: Characteristics of Complexes of Conics in Space of Four Dimensions.—T. M. Cherry: Integrals developable about a Singular Point of a Hamiltonian System of Differential Equations.—R. A. R. Tricker: A Helical Method of focussing β-rays.—D. R. Hartree: Some Methods of estimating the Successive Ionisation Potentials of any Element.—Sir Joseph Larmor: Why Wireless Electric Waves can bend round the Earth.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. F. O. Bower: Presidential Address.

INSTITUTE OF ACTUARIES, at 5.—A. D. Besant: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—W. B. Woodhouse and others: Discussion on The Interconnexion of Power Stations.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre), at Armstrong College, Newcastle-on-Tyne), at 7.15.—W. T. Macca Chairman's Address.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—J. G. Turn Presidential Address.—E. D. D. Davis: Some Points in the Patholo Diagnosis, and Treatment of Disease of the Maxillary Antrum.

MEDICAL SOCIETY OF LONDON, at 8.30.—Clinical Evening.

TUESDAY, OCTOBER 28.

ROYAL DUBLIN SOCIETY (at Royal College of Surgeons, Dublin), at 4.15. H. H. Jeffcott: The Determination of the most Economic Size of Pipe Li for Water Power Installations.—Dr. W. R. G. Atkins and G. T. Harri Seasonal Changes in the Water and Heleoplankton of Fresh Wat Ponds.—K. C. Bailey: The Synthesis of Urea from Carbon Dioxide a Ammonia under Atmospheric Pressure.—Miss S. D. King: Oogenesis *Lithobius fortificatus*.—A. Subba Rass, F. W. R. Brambell, and Prof. B. Gatenby: Observations on the Golgi Bodies in the Living Cell.

INSTITUTION OF CIVIL ENGINEERS, at 6.—E. Crammond: The Economi Position of Great Britain.

INSTITUTION OF AUTOMOBILE ENGINEERS (at 83 Pall Mall) (Informal Mee ing), at 7.—Demonstration and Discussion of Devices connected wit Cars not yet on the Market.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Special Gener Meeting (Members only).

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at Elmbank Crescent, Glasgow), at 7.30.—Discussion on Paper by A. J. Taylor: Pulverised Fuel in its Commercial Aspect.—E. F. Spanner A Proposed Form of Bow Construction.

WEDNESDAY, OCTOBER 29.

INSTITUTE OF PHYSICS (at Institution of Electrical Engineers), at 5.30.—Sir Oliver Lodge: Electrical Precipitation ("Physics in Industry, No. vii.).

THURSDAY, OCTOBER 30.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Major J. S. Buchanan: The R.Ae.C. Light Aeroplane Competitions.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section and Faraday Society) (at University College, Nottingham), at 5.30.—Dr. W. L. Bal and others: Discussion on Textiles.

CHILD-STUDY SOCIETY, at 6.—Dr. H. Y. Trotter: The Teaching of Music.

SOCIETY OF DYERS AND COLOURISTS (Midland Section) (at University College, Nottingham).—N. C. Lamb: The Dyeing of Leather.

INSTITUTION OF LOCOMOTIVE ENGINEERS (at Engineers' Club, Coventry Street, W.), at 7.—J. E. Anderson: Presidential Address.—Sir Henry Fowler: Solid Crank Axles for Locomotives.

FRIDAY, OCTOBER 31.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Anatomy and Malformations of the Heart—(3) Specimens illustrating Points in the Applied Anatomy of the Human Heart.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Discussion on Engineering Novelties at the British Empire Exhibition.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Section) (at Leeds).—Prof. W. T. David: Heat Loss in Gas-Engines.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section) at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—L. Eveleigh: Professional Secrets and Trick Kinematography.—J. Noble: Out of the Ink Pot and how it is done.

JUNIOR INSTITUTION OF ENGINEERS (at 39 Victoria Street), at 7.30.—H. J. N. Riddle: Audio-frequency Transformers.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Cleveland Institution, Middlesbrough), at 7.30.—L. W. E. Rowbotham: Chairman's Address.

SATURDAY, NOVEMBER 1.

GILBERT WHITE FELLOWSHIP (at Queen Square, W.C.), at 3.—Sir A. Daniel Hall: The Countryside in English Literature (Presidential Address).

PUBLIC LECTURES.

SATURDAY, OCTOBER 25.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: Social Life amongst Insects—(1) Ants, Bees, and Wasps.

MONDAY, OCTOBER 27.

UNIVERSITY COLLEGE, at 5.30.—Sir Mark Hunter: The History of English Pronunciation.

WEDNESDAY, OCTOBER 29.

UNIVERSITY COLLEGE, at 5.30.—L. Newcombe: University College Library and Modern University Libraries.

FRIDAY, OCTOBER 31.

UNIVERSITY COLLEGE, at 5.15.—Lt.-Comdr. A. S. Elwell-Sutton: China, her People and the Present Situation.

SATURDAY, NOVEMBER 1.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Some Famous Pharaohs.

NATURE

SATURDAY, NOVEMBER 1, 1924.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

ditorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
elegraphic Address: PHUSIS, WESTRAND, LONDON

NO. 2870, VOL. 114]

Popular Science Exhibitions.

NOW that the British Empire Exhibition has come to an end—for this year at any rate—it may be of interest to record some impressions of the manner in which the Royal Society's Exhibition of Pure Science, which was arranged in the Government building, has appealed to the public, and of the extent to which it has fulfilled the objects with which it was organised.

The arrangement of this exhibition was undertaken by the Royal Society, at the request of the Government, for the purpose of showing the essential part played by pure science among the multifarious interests and activities of the Empire. Everywhere in the great Exhibition the applications of science to industry were to be seen, but the fundamental work of scientific inquiry, in which many of them had their origin, would have been unrepresented unless some special effort had been made to bring it to the public notice. Accordingly, this exhibition, illustrating many aspects of purely scientific research at the present time, and indicating how industry has developed from similar inquiries in the past, was arranged.

The exhibition has not been without its humours. One was the difficulty of returning a satisfactory answer to the inquirer who, after spending some time in the galleries, said, "Yes, but how do you know there is an atom, and how do you know there are electrons inside it?"; and another, the problem presented by a visitor who, on observing that the Milne-Shaw seismograph has a rotating drum giving a record which has to be changed every twenty-four hours, asked, "What happens if there is an earthquake while you are changing the record?"

Nevertheless, it may be said that the exhibition has been an unqualified success. The public, non-scientific as well as scientific, has been really interested, and some, at least, must have gone away with a clearer understanding of the purposes for which men devote their lives to scientific experiment and inquiry. This success may be attributed largely to the policy adopted of making the exhibition a living one. The exhibits were contributed by scientific workers actually engaged in the researches represented, and supplemented, where necessary to illustrate a subject fully, by instruments contributed by some of the leading makers. Wherever possible, actual demonstrations were given, and a scientific staff was in attendance throughout to carry out the demonstrations and to explain the exhibits. This policy was fully justified by the continued interest of visitors.

The Handbook published in connexion with the exhibition has been of great assistance. In this book is

made available, for the small cost of a shilling, a series of non-technical articles on current scientific topics by leading authorities; and the best proof of its popularity is the fact that more than two thousand copies were disposed of, while its sale is increasing as it becomes better known, and is likely yet to continue now that the Exhibition is closed.

The encouraging success which has met this attempt to present pure science in a less austere light than often surrounds it in the eyes of the general public, leads naturally to the inquiry as to whether a greater use cannot be made of scientific exhibitions as a means to this end. Nothing but good can result from such efforts to spread a clear understanding of the true aims and purposes of science. That pure science is the modern expression of the elementary desire for knowledge—for the discovery of natural truths—that it is only by the disciplined quest in unknown fields that those benefits which science gives to the human race can accrue, is too little understood and too easily lost sight of, because of the very magnitude of the results themselves.

It ought to be possible to make an exhibition of this kind an annual event. The Scientific Products Exhibitions, organised by the British Science Guild in 1918 and 1919; the Scientific Novelties Exhibitions held at King's College, London, in connexion with the King Edward's Hospital Fund in January 1923 and 1924, and experience at Wembley show that such displays of scientific work and results are much appreciated by the public. The desire for truth is at least as strong and as laudable an inspiration to the human spirit as the desire for beauty, and an event of this kind might well become to the world of science what the annual exhibition of the Royal Academy is to the world of art.

Such an annual exhibition would serve to maintain interest in the work of scientific inquiry, and help to keep it in the public mind in its just relation to the other activities in life. To men of science it might become a valuable auxiliary to the usual methods of publication of new scientific work, by reaching a wider public than the transactions of the scientific societies or the scientific periodicals can ever hope to do; and to the museums, it could be a source from which to obtain objects of interest from time to time, and thereby do much to prevent such national misfortunes as, for example, the dispersal, during the War, of the apparatus used by H. G. J. Moseley in his historic work on the X-ray spectra of the elements. It is to be hoped, therefore, that whatever facilities or funds are required to secure the continuance of the pure science exhibits and demonstrations now at Wembley will be provided.

Archæology of Stonehenge.

The Stones of Stonehenge: a Full Description of the Structure and of its Outworks. By E. Herbert Stone. Pp. xv+150+36 plates. (London: Robert Scott, 1924.) 21*s.* net.

MR. STONE is to be congratulated on having written a book which has long been wanted for giving a good up-to-date description of Stonehenge. He has gone very thoroughly into the subject, viewing it from all points, describing the arrangement of the stones, their source and geological nature; also a great many little items of particular interest which the monument and the site afford, and they are very well illustrated by photographs and drawings. Being a civil engineer and of much experience, his profession has taken him to places and amongst primitive people where he was able to note ways and means of working stones analogous to those at Stonehenge, so he is well qualified to give a description. This will be seen in the chapter on quarrying, where he mentions and illustrates methods in use in India comparable with those employed by neolithic man, and a stone maul can be seen in one photograph which is identical with those found at Stonehenge.

To gain a greater knowledge of this subject, Mr. Stone has experimented upon actual Sarsen boulders derived from the source the Stonehenge Sarsens were taken from. He has culled the best information from modern archæology and gives also the opinions and accounts handed down to us from early pioneers, some of them rather impossible views, but amongst them a certain amount of good reasoning which the reader may find pleasure in sifting. He also quotes the account of the foreign stones given by Dr. Thomas, whose long and patient search for their source was rewarded by finding all the Stonehenge varieties at one locality in Pembrokeshire, putting beyond doubt the source of their origin.

The author is at his best as an engineer when he explains a simple method of erecting the stones, which, if not exactly similar in all details, must approach very nearly the one employed by the builders. He calculated with precision the weights and strains and the forces necessary for movement, and has shown by actual experiments carried out by himself how primitive people, with simple contrivances, could handle massive stones and set them up with great accuracy and with comparatively little labour. Thick raw-hide ropes no doubt would have been used, and their great tensile strength can be judged when remembering what a strain an ordinary violin string can endure. The chapter devoted to this account of engineering skill will certainly be read with great interest.

The author is in error over a fallen foreign stone h figures in Plate 6, Fig. 2, in supposing the holes seen on it were made, after it had fallen, Romano-British people for grinding corn, first, use the cupped holes would be too small, and adly, because the stone is evidently a lintel. It irved in the same way as are those of the outer e, but in this one the curve is sharper, showing elonged to something smaller. The holes in the e are equidistant from the ends and are dowe s like those in the big lintels, and this stone may nerly have fitted over the terminal upright stones he horseshoe. It is unlikely that a Romano-ish peasant would have gone to the arduous task aking holes in a stone so hard when querns could asily procured. That this was so is evident from great quantity of broken querns found in British ges; even those of Andernach lava are fairly mon, and no doubt were brought in the finished e by hawkers and perhaps by the same route as Romano-Gallo ware.

love for mathematics and careful measurements have prompted the author to become interested Sir Norman Lockyer's conclusion that the place been laid out on astronomical lines. He has lently studied the subject very carefully, and his osition of it is of decided interest. It has been bitterly controversial subject amongst archæo-sts, but is nevertheless one which cannot be lightly sed over, for there are certainly some points in which are well worthy of consideration. The tention has been that Stonehenge is sepulchral, ause stone circles and dolmens almost invariably lter the dead, and that they do may be taken for nted.

Recent research at Stonehenge makes it appear ond doubt that the site on which it stands has had ng history, and certain appearances have come to t of changes of building anterior to the present nument. The ditch is extremely primitive and l within neolithic times. It was certainly defensive, there is a palisade at the entrance, and at that e it would be secular, sheltering a little community der a much-respected chief. When he died he uld have been buried, possibly under a dolmen in middle of the enclosure, and a circle of stones cted within the rampart. It would then have come sacred, and the ditch, no longer wanted, would allowed gradually to silt up. After a long lapse years, and for some unknown reason, it was decided erect Stonehenge, and to do so the dolmen and cle disappeared. Whether the neolithic inhabitants the country decided amongst themselves to do this, were prompted to it by the advent of a foreigner, it is impossible to say, but the latter idea is the more probable, and although incapable of such a conception themselves, they would willingly do the work from tuition.

It is quite evident that the place was not a first attempt at building, and must have been designed by a master mind and a great engineer who had had much previous experience. He probably came from the south, and may even have participated in megalithic work in Egypt, though not an Egyptian. Under his careful guidance and drilling, and perhaps rehearsal of the work, he made the people do all he wanted. Whether or not he had acquired all the knowledge of the Egyptians one cannot say, but he must have been able to make an elaborate plan in laying out the place, and to calculate with fair accuracy the weight of stones and strain upon ropes, and other mechanical details.

Every one seems to be agreed that Stonehenge is definitely orientated towards the north-east, but the chief question is whether it was built entirely for sepulchral use. Probably it was not, because, having been previously a sepulchral spot, it is scarcely likely they would interfere with the buried remains and replace them with those of another person. It would preserve its sanctity because of the previous burial and be combined with the purpose for which it was erected. If that, or one of the purposes, was for determining the beginning of a particular season of the year, no very precise astronomical knowledge would be necessary, and it might well have been used for this purpose. A building so unique would command fame and reverence, making it a centre for the gathering of headmen of tribes to settle their important matters. No interment belonging to the period it represents has yet been found; cremated remains that have occurred belong to the Bronze Age, and therefore later in date, show that although it may have been secularised it still retained a sacred significance to a later race. The east and west stones on the rampart have not yet been archæologically explained, and one which was examined did not appear to be for sepulchral use.

The author has admirably expounded his theory in the chapter devoted to it, and even those who disagree with the astronomical theory will find much matter for careful consideration. Whether the research when concluded will throw more light upon the matter cannot be foretold, but when all is said and done there will yet be questions which will elicit the answer, "We do not know."

The book will prove interesting and instructive, not only to students of archæology, but also to all who take an interest in Stonehenge.

Rhododendrons.

Rhododendrons and the various Hybrids. By J. G. Millais. Second series. Pp. xii+264+53 plates. (London: Longmans, Green and Co., 1924.) 210*s.* net.

IT says much for the hold rhododendrons have secured in the estimation of horticulturists that Mr. J. G. Millais was so much encouraged by the success of his first work on the genus in 1917 as to prepare and publish a second volume of the same sumptuous character as its predecessor. The cost of the two volumes amounts to eighteen guineas, and there is certainly no other genus of trees or shrubs in which public interest is sufficiently strong to render possible the profitable issue of such volumes as these.

Whilst no genus of shrubs is so popular at the present time as Rhododendron (including, as it does, Azalea), that popularity is by no means a new one. Since the middle of last century at least, rhododendrons have been regarded as one of the most essential elements of the open-air garden. No rhododendron is indigenous to the British Isles, and only some half-a-dozen to the whole of Europe, the best known of which are the two species so abundant on the mountains of Central Europe—the so-called "Roses des Alpes." In 1736 *R. maximum* was introduced from the mountain summits of the Carolinas and Tennessee; in 1763 *R. ponticum* was brought from the Pontus region in Asia Minor; and between that date and 1809 were acquired for English gardens *R. caucasicum*, *R. catawbiense*, and *R. punctatum*. By this date also three species of the deciduous-leaved or Azalea section had reached Great Britain, namely, *R. viscosum* and *R. calendulaceum* from North America and *R. flavum* from Asia Minor. It was to these comparatively few species that the labours of the hybridists of one hundred years ago were necessarily confined. The range of colour amongst the evergreen species was a narrow one and extended only from white to pink and purple, but in 1825 *R. arboreum* from Northern India produced for the first time its blood-red flowers in Britain and thereby added a new and very valuable pigment to the hybridiser's palette. It may indeed be truly said to have completed the group of species from which the common type of garden hybrid rhododendron as we knew it up to twenty or thirty years ago was almost entirely derived.

Sir Joseph Hooker, during his famous journeys in the Himalaya (1847–1851), especially in Sikkim, sent home seeds of practically all the species native of that region, but most of them are only hardy in the southern and western maritime counties of England, and it was not until the 'eighties of last century that their "blood" began to show in the hardier hybrids. But now some of the best hardy varieties owe their meri largely to what they have inherited from *R. Aucklandi barbatum*, *Thomsonii*, and *ciliatum*. The Himalaya species may be said to have initiated the second phas in the development of the modern garden rhododendron

The third and contemporary phase is bound up almos entirely in the exploitation of the flora of Wester China and Tibet, which we owe in the main to fou British collectors, namely, Wilson, Forrest, Kingdor Ward, and the late Reginald Farrer. Wilson's travel in China ended in 1910, and the rhododendrons he intro duced were fully dealt with in Mr. Millais' first volume The new volume is for the most part concerned with the work of the last three collectors, of whom George Forrest is much the most prominent. Mr. Millais cal culates the number of species of rhododendron now known to be about 670, about 300 of which have been brought to the knowledge of botanists by that collector

In assembling in one volume full and adequate descriptions of all the new species published up to the present time, Mr. Millais has rendered a very valuable service to rhododendron lovers. The arrangement is alphabetical, but the student is helped by being told the "series" to which each species belongs, and in that way is given a useful lead towards visualising its genera character. As a matter of fact, the genus is in a rather chaotic state at present. Species have been described in large numbers, many on very trivial differences, but no serious attempt has yet been made to co-ordinate them. The influx of new material is still going on, so perhaps the time for that is not yet.

Mr. Millais' book contains a good deal more than mere descriptive matter. He commences with a dissertation on shrub gardening in general, which, although somewhat outside the main theme, is extremely interesting and useful. That there is no one better qualified to discourse upon it, all who know Mr. Millais' own charming garden at Horsham will cordially agree. A valuable chapter on Chinese rhododendrons and the work of Forrest, Ward, and Farrer contains much original information supplied by the collectors themselves about rhododendrons as they were seen growing in their native habitats and the conditions under which they exist.

There is nothing rhododendron growers are more keen about than hybridisation. So many wonderful results have been obtained in the past that one cannot be surprised at that. Hybridising these shrubs is not unlike the labours of the old-fashioned gold miners. Conducted on well-reasoned lines, one may always be sure of obtaining something good, with the possibility of an occasional large nugget such as the late Sir Edmund Loder secured in *Rhododendron Loderi*. The author's useful résumé of the work done by prominent

ers during recent years will be read with much
e st. A chapter on cultural matters concludes the
r luctory part of the work.

M Millais is to be congratulated on the successful
plishment of a very arduous task. He has
ht together very nearly all the knowledge about
dendrons that really matters — which is a great
r to have done. Handling his book, one could wish
imes that it were not so large, but then we should
missed the fine coloured pictures by Miss Beatrice
ns and Miss Winifred Walker. Other coloured
s by Miss Snelling are excellent, and besides all
he book is lavishly illustrated by reproductions
photographs of plants both wild and cultivated.

W. J. BEAN.

The Origin of Solubility.

ility. By Prof. Joel H. Hildebrand. (American
emical Society Monograph Series.) Pp. 206. (New
rk: Chemical Catalog Co., Inc., 1924.) 3 dollars.

O a reader who has not followed recent American work on solubility, the contents of Prof. Hildebrand's book provide a pleasant surprise. Instead of a compendium of data, there is here a real attempt to develop a general theory of solubility, and of the wider problems of miscibility in liquids, and of the properties of the resulting mixtures. The starting-point of this general theory is not the familiar Law of Osmotic Pressure of van 't Hoff, but the more fundamental Law of Vapour Pressures of Raoult. Thus, in the case of certain mixtures, Raoult's law is valid over the whole range of concentrations from 0 to 100 per cent., whereas van 't Hoff's law is limited to dilute solutions and, even when modified, cannot be extended in a similar way. An ideal solution is therefore defined as one which obeys Raoult's law at all temperatures and pressures. This depends on the internal forces remaining undisturbed on substituting molecules of one kind for molecules of solvent. The author discusses what are the properties of the individual liquids, the stability of which is likely to lead to this result, and concludes that equality of "internal pressure" is the most important factor. Moreover, if this condition is fulfilled at one temperature and pressure, it is likely to be realised over the whole range.

Deviations from Raoult's law are of two types. "Negative" deviations are accompanied by a contraction and evolution of heat on mixing, and may be accounted for, at least in some cases, by the formation of unstable compounds of solvent and solute. "Positive" deviations, accompanied by an expansion and absorption of heat on mixing, are less easily explained. In general they could be accounted for by the *association* of one of the pure liquids, so that dilution with an inert solute would give rise to *dissociation*; but, when this is regarded as the only possible explanation, it leads to the assumption of polymerised molecules of argon in solution in liquid nitrogen, and in general to the necessity for assuming an altogether unreasonable degree of molecular complexity in order to account for the larger deviations. Positive deviations from Raoult's law can also be "explained" by the existence of wide differences in "internal pressure," but this is in a sense little more than a paraphrase.

The author is, however, considerate enough to give a simpler (if less rigidly proved) explanation, by using the familiar classification of liquids into (i) "normal" liquids with low dielectric constants and small residual fields of force round the molecules, and (ii), "polar" liquids with high dielectric constants and large or unsymmetrical fields of force. The polar molecules, he says, have an abnormally great attraction for each other, thus producing greater cohesions, internal pressures, surface tensions and heats of vaporisation. They therefore tend "to squeeze out, as it were, non-polar or slightly polar molecules from their midst"; and on account of this selective attraction of the polar molecules for each other, "the squeezing-out effect may be greater than it would be in the case of high internal pressure alone, unaccompanied by polarity." The result is a strong positive deviation from Raoult's law, with a corresponding influence on solubility. This classification is, of course, not a rigid one, but it agrees well with the familiar experience of all chemists that "if substances are divided into two groups, polar and non-polar respectively, those within either group are usually most soluble in the other substances within the same group and least soluble in those of the other group."

The summary given above of some of the points discussed by the author would probably give quite a wrong impression of the book, by suggesting that it is qualitative and non-mathematical in character. It may be taken as an unsolicited testimonial to the skill of the author that it should be possible to deal in this way with a book that is rigidly thermodynamical in its method of treatment. He has, indeed, written in such a way that a reader who is unskilled in thermodynamics and who "funks differentials" can nevertheless follow his argument with comfort. Such a reader is permitted to shut his eyes whilst traversing the thermodynamic tunnels, in the expectation that he will soon emerge, not merely into the daylight of an open cutting, but into broad stretches of open country. The book is therefore one that is well worth reading, and the author is to be congratulated on his success in presenting a difficult subject in so attractive a form.

T. M. L.

Hydrodynamics.

Hydrodynamics. By Dr. Horace Lamb. Fifth edition. Pp. xvi + 687. (Cambridge: At the University Press, 1924.) 45*s.* net.

LAMB'S text-book has long been the chief storehouse of information of all workers in hydrodynamics. One may note that the interval between the first and second editions was 16 years, and that successive editions have followed at intervals of 11, 10, and now 8 years respectively. Perhaps the steady decrease is to be attributed to the development of interest in the subject, which has during the last ten years come into closer relation with experience than the most optimistic student could have anticipated previously. In any case, the fifth edition is welcome, for it contains not only all the good features of its predecessors, but also most valuable accounts of recent discoveries. Dr. Lamb's alertness to modern advances may be estimated from the fact that ten entries relating to Prof. G. I. Taylor occur in the index. Abundant references to original papers are given in the footnotes.

A new section (91*a*) gives a short account of the expansion of a spherical cavity in water due to an internal explosion, and of the collapse of an exhausted cavity. Section 159*a* deals with the two-dimensional motion of solids in a liquid with uniform vorticity. Section 205*a* gives a new theorem relating to small oscillations of a gyrostatic system about a steady motion. Rayleigh proved that the normal modes of vibration of a non-gyrostatic system were those that made the periods stationary for small variations in the adopted ratios of the co-ordinates. Lamb here proves the corresponding theorem for a gyrostatic system.

The account in Section 284 of the propagation of a wave of discontinuity in air has been much improved by the inclusion of a discussion of the modification introduced by conduction, with an estimation of the extent of the region of transition. Section 330*a* describes the theory of a case of lubrication. In Section 334*a* several cases of the transference of momentum in a viscous fluid in a non-steady state are worked out, and also the theory of the maintenance of an ocean current by a steady wind blowing over the surface. The effect of porous bodies in absorbing sound is discussed in Section 360*a*. A few simple cases of turbulent motion are treated in Section 366*a*, *b*, and *c*. The nature of the theory of the motion of solids in a real fluid is outlined in Section 372*a* and *b*. A new section at the beginning of the chapter on rotating masses of fluid gives proofs of the theorems of Poincaré and Lichtenstein on the possible modes of rotation of a fluid mass. Two slips of the pen which have be noticed are, on p. 643, $2{\cdot}2 \times 10^{19}$ is printed instead $1{\cdot}1 \times 10^{19}$, and, on p. 648, $-\omega^2 z$ appears instead of for the z acceleration.

A few remarks concerning Dr. Lamb's use of t reversed sign for the velocity potential may not be o of place. He justifies this course on two ground First, it gives the velocity potential the same sign as t impulsive pressure needed to start the motion; secon it completes analogies with other branches of math matical physics. Neither of these arguments appea to the reviewer to have much weight. From analo with elasticity, where the positive stress and strain bo correspond to an extension, an impulsive tension appea to be a more suitable standard than an impulsi pressure, and the velocity potential without reversal h the same sign as the impulsive tensions. The use pressure instead of tension in hydrodynamics aris from the fact that it is usually (though not always) t pressure that is positive in fluids; the adaptation of t sign of the velocity potential to this fact tends obscure the physical analogy between elasticity a hydrodynamics. Again, while the reversed sign agre with the usual practice in electrostatics, it disagre with that usual in gravitational theory, which is mo closely associated with actual hydrodynamic problem In each of these cases the current convention has be adopted purely in order to reduce the number of tim the minus sign has to be written; which is in itse a reason for not reversing the sign of the velocit potential. H. J.

Psychical Research.

Experiences in Spiritualism with D. D. Home. E the Earl of Dunraven. Pp. iv+285. (London Society for Psychical Research, 1924.) 7*s.* 6*d.*

THIS book ought to have been published long ag In a way indeed it was, to wit in 1870, but onl for private circulation, on account of the violer prejudices which its subject then excited both i religious and in scientific circles. It is a record of t marvels which seemed to those present to happe in connexion with D. D. Home, the most famou "medium" of modern times, and is composed mainl of reports, written by the present Earl of Dunraver then Viscount Adare, to his father, on seventy-eigh sittings with Home in the years 1867–69; but in te cases the notes were taken by the late Earl, who als wrote an introduction. The present Earl has now r printed the material and equipped it with a prefac and with a lucid and temperate introduction by S Oliver Lodge; but he has not attempted to fill in th

which were left in the evidence where matters considered too intimate for publication. After a of more than fifty years, most of these could surely been filled in without offence, and thus have teracted the attenuating effect which the mere of time has on the scientific value of any historical native. Nor is the recording itself as full and expert rookes's account of his experiments with the same ium.

evertheless, Lord Dunraven has put under a obligation all students of the secular struggle een the champions of "law," convention, pre-ce, scepticism, conservatism, on one hand, and of t," eccentricity, open-mindedness, credulity, re-tion, on the other. The continuance of this ggle is due to the fact that the progress of know-e demands a co-operation of both these tendencies, hat neither can lay exclusive claim to the term entific"; while the question as to which party is t cannot be settled by any appeal to general iciples, but only (if at all) by patient and prolonged mination of each case.

ll this applies with peculiar force to "spiritualism," h excites strong emotions on both sides, and dis-s a dramatic clash between established principles subversive testimony. But it would be utterly ientific to burke investigation on this account, r the fashion of Hume, by declaring that "miracles" alleged, and that miracles are impossible. This is e *a priori* dogmatism, which is discreditable alike hilosophy and to science.

may be that the times are not yet ripe for a y scientific inquiry into the facts alleged; certainly her party as yet welcomes examination. The man cience professes to be more interested in, say, the hridia of worms than in the immortality of his soul, le the spiritualist, though he rests his case on ervable facts, fights singularly shy of test conditions. n when a "medium" can be got to submit to mination, it is usually hard to find a man of science will conduct it; as was recently shown when, in e of a handsome salary, such a post went a-begging, il a physicist already compromised by interest in the ernormal accepted it, and speedily exploded a ous medium.

erhaps the truth of the matter is that both sides not quite sure of their ground and afraid to test r convictions. Still, one cannot read Lord Dun-en's book without feeling that progress is being le, though slowly; perhaps it is not too much to e that, in another fifty years, science will have n an explanation satisfactory to both the scientific ker and the spiritualist of the mysteries that are in dispute.

F. C. S. S.

Our Bookshelf.

The Morphology and Evolution of the Apes and Man. By Dr. Charles F. Sonntag. Pp. xi + 364. (London: J. Bale, Sons and Danielsson, Ltd., 1924.) 12*s.* 6*d.* net.

FULLY sixty years ago, Huxley systematised our knowledge of the anatomy and nature of anthropoid apes in a famous treatise to which he gave the title "Evidence as to Man's Place in Nature." Anatomists have been busy since then; there has been an enormous output of papers relating to the anatomy of apes, and there has grown up a great need for an ordered presentation and interpretation of the new material.

Dr. Charles F. Sonntag, Prosector to the Zoological Society of London, has stepped into the breach and sought to supply this need in "The Morphology and Evolution of the Apes and Man." This book, Dr. Sonntag informs us in his preface, "is intended to serve as an introduction to Anthropology, for it deals with the first steps in that science, namely the relations of Man to lower animals."

The scope of Dr. Sonntag's treatise is best indicated by citing the contents of its chapters. Chapter i. is devoted to a systematic account of lemurs and Tarsius, Chapter ii. to the New World monkeys, Chapter iii. to the Old World monkeys. Then follow nine chapters on the anthropoid apes. One is devoted to a description of their external characters, habits, and classification; then follow others in which plain accounts are given of their skeletons and teeth, of their muscles, of their organs of digestion, of their organs of circulation, of their respiratory systems, of their urino-genital systems, and of their nervous systems. In all of these chapters, Dr. Sonntag keeps his personal opinions in the background, being content to play the part of descriptive anatomist, leaving the interpretation of his facts to others.

In a final chapter a brief account is given of the evolution of the primates, the text of this chapter being greatly assisted by a clearly drawn phylogenetic tree. In this chapter, as in others, Dr. Sonntag is an eminently safe guide for both student and expert, for he has preferred to give a detailed account of the anatomy of apes, rather than to discuss the problems relating to their origin. Anatomists are indebted to Dr. Sonntag for this work, particularly for the full bibliography which is appended.

Institution of Petroleum Technologists. Standard Methods of Testing Petroleum and its Products. Pp. x + 102. (London: Institution of Petroleum Technologists, 1924.) 6*s.* net.

THE Committee appointed by the Institution of Petroleum Technologists to standardise methods of oil-testing has, under the above title, published its first report in the form of a concise manual. It was no easy task to criticise existing methods, to comment on relative advantages and disadvantages inherent thereto, to keep pace with current developments, and at the same time to issue an authoritative work formulating agreed methods of oil-analysis consistent with home and foreign procedures; but the Committee has

acquitted itself well. A compromise between methods dictated by custom, previous decrees of the British Engineering Standards Association, publications of the American Society for Testing Material and the American Bureau of Standards, has been achieved, to the lasting benefit of petroleum chemists and the industry in general.

Methods of testing oils and suitable apparatus are discussed, but the thorny problem of nomenclature has been left alone, owing to the impossibility of considering it on other than an international basis—a wise decision. Petroleum products are dealt with as gasoline, white spirit, kerosene, gas oil, lubricating oils, transformer oils, fuel oils, asphalt, and wax, and under each class appropriate tests are given, these tests being differentiated by "serial designations," *i.e.* reference letter to the class of product and serial number to the precise test. In the language of the Committee "I.P.T. Special Designation—G.O.4" will in future indicate the standard test for sulphur in gas oil (class G.O., test No. 4), implying the use of a bomb-calorimeter of approved specification with manipulation as prescribed; similarly for other products and their routine testing. No degree of finality of methods is achieved (nor was that desirable) in the report; the fabric on which the I.P.T. standardisation is built up is sufficiently elastic to permit of modifications and additions in technique demanded by future developments. H. B. MILNER.

The Journal of the Institute of Metals. Vol. xxxi. Pp. xi+680+40 plates. Edited by G. Shaw Scott. (London: Institute of Metals, 36 Victoria Street, Westminster, 1924.) 31*s.* 6*d.* net.

THE papers contained in the present volume are mainly of scientific interest. There are several studies of the equilibrium in binary and ternary alloys, including a remarkably well illustrated account of the alloys of copper and cadmium. Sir Henry Fowler gives a survey of the use of non-ferrous metals in engineering, and the president, Prof. Turner, devotes his address mainly to the importance of research in metallurgy. A practical investigation of the failure of some brass tubes, by Mr. Millington and Prof. Thompson, is chiefly interesting through leading the authors to a rather speculative, but highly ingenious, view of the mechanism of fatigue. The discussion on this paper shows how diverse are present opinions as to the nature of fatigue. A paper from Stockholm, partly covering the same ground as a recent communication from the National Physical Laboratory, treats of the study of inter-metallic compounds by means of X-rays. The volume contains a great deal of interesting matter, and, as usual, includes very full abstracts of the current literature relating to non-ferrous metallurgy.

Lunge and Keane's Technical Methods of Chemical Analysis. Second edition. Edited by Dr. C. A. Keane and P. C. L. Thorne. Vol. 1. Pp. xx+704. (London and Edinburgh: Gurney and Jackson, 1924.) 63*s.* net.

THE new edition of this important work is distinctly better than the earlier one. It is to be in six volumes, each complete with its own index (besides a general index for the whole series), and the contents have been rearranged so that associated subjects are grouped together more conveniently than in the first edition.

Dr. Keane has enlisted the assistance of British experts throughout, and certain of the sections, such as "Fuel" and "Cyanides," have been entirely re-written, while others are materially altered. The important sections on sulphuric acid, chlorine, and alkali have been brought up-to-date by Dr. J. T. Dunn. Dr. J. S. G. Thomas is responsible for "Gas Analysis" and for a noteworthy new section on "Physical Methods," while a new chapter on "Electrolytic Methods" is excellently dealt with by Dr. H. J. S. Sands.

Very few printer's errors have been observed, and except for a few of the illustrations, the book is well turned out. Altogether, this first volume represents a notable advance on the earlier edition, and it is to be hoped that the high standard will be maintained through the remaining volumes. T. W. H.

The Recent Development of Physical Science. By William Cecil Dampier Whetham. Fifth edition. Pp. xvi+313+16 plates. (London: John Murray, 1924.) 9*s.* net.

TWENTY years ago, Mr. Whetham wrote a remarkable book, in which he gave, in pleasant narrative form, an account of the discovery of the electron, and other matters which were then new in physical science. The mobile electron has moved a long way in twenty years and as a result nearly half of the new version of the book is devoted to describing ideas and facts which had scarcely come into existence when the first edition was issued. It would, however, be an injustice to suggest that Mr. Whetham has limited himself to telling, as so many others in recent years have done, the story of the electron and nothing else. Just as the earlier work included chapters on the liquefaction of gases, and on the processes of crystallisation from fusion or solution, so the later additions include a chapter on "Matter, Space and Time," under the appropriate motto "Oh, dear! What can the matter be?" and a chapter on astrophysics. On account of its breadth of treatment, the book can be commended to readers who hold that neither the naked ion of thirty years ago, nor the naked electron of to-day important as they are, can claim a complete monopoly of interest in physical science.

Technical Writing. By T. A. Rickard. Second edition, re-written and enlarged. Pp. ix+337. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 10*s.* net.

THE second edition of Mr. Rickard's book has been thoroughly revised and enlarged. It is a useful guide to the writing of technical papers, and, although the worst examples of faults to be avoided are more often found in the technical press of the United States than in Great Britain, even a superficial student of publications on applied science must have noticed that such slovenly expressions are being increasingly used. The new sections include a chapter on "The Wrong Word," and another on punctuation. The sections on style are slight but sound, the aim of the author being to encourage clearness and simplicity in the statement of facts.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Agricultural Research.

ON returning from a lecturing tour in Canada and the United States, I find among the files of NATURE "Cantab's" interesting letter in the issue of September 27.

I had no intention of being despondent in my address to Section M (Agriculture), nor is there reason for despondency. It is true that science has given only few aids to agriculture of the order of 100 per cent. increase in yield, but much has been done of a less spectacular nature, and agricultural experts are now able to advise farmers with considerably more certainty than was the case even thirty years ago. There have been great changes in practice, and science has helped considerably.

The history of agriculture shows that advances have come in three ways: from purely empirical methods tried by farmers with no definite scientific plan; from experiments on empirical lines made by trained workers: and from advances in pure science, whether initiated in a purely scientific, or, as has often happened, in a technical laboratory. It is a fact that in the past some of the biggest advances have been made by empirical methods, but one cannot infer that scientific methods are therefore inferior; only in recent years have they been adequately tried. Our knowledge of the biochemical changes in the soil, of the soil micro-organisms, the soil solution, and the soil colloids, quite apart from the theoretical work to which "Cantab" referred, has all come as the result of purely scientific work, done entirely with the view of gaining information, and with no idea of practical applications. Little of this knowledge is yet used in practice, for the simple reason that no one has found a way of using it, but history shows that the application comes sooner or later once the scientific discovery is definitely established. There is every reason to hope that agricultural science has fresh triumphs in store.

In recent years it has been easier to apply scientific methods in agricultural investigations because many of those responsible for the management of agricultural institutions, and especially the younger men, appreciate their value and realise the necessity for the so-called "academic work." No honest person working on scientific lines would ever commit himself to a definite promise that a particular investigation would have practical results; he can, however, so conduct it that it will yield sound knowledge. It is of course true, as "Cantab" points out, that epoch-making discoveries have not yet come direct from team work or directed research. But it must also be recognised that advances of this order are in any case very rare, and when they come it is largely as the result of the less spectacular, but none the less real, advances in knowledge which can be made in the well-equipped organised institution. No research institution can do more than hope for first order discoveries, but the staff can, at any rate, ensure good development work, and secure advances which in the aggregate count for much.

Like all other forms of research, agricultural research is finally limited by the state of knowledge of other branches of science; and a logical scheme of assistance would recognise the claims of all pure science. The present schemes may not be very logical, but knowing something of the methods by which a research institute has to be sustained, I am not sure that the departments of pure science have always adopted the best methods for obtaining assistance. A great difficulty of research institutions—and it must be far greater to the layman—is to know just what are the methods and the results of science, in other words, whether the limitation imposed by lack of knowledge in pure science lies in the man or the science. The agricultural investigator received his training in pure science it may be ten or twenty years ago; he tries to keep up, but is overwhelmed by the enormous and ever-increasing volume of papers of very varying merit and lucidity. The Chemical Society facilitates his task by issuing annual reports on the different branches of chemistry, but many other scientific societies have not followed this good example. There must be many papers in pure science buried in the libraries which would prove of great value to agriculture if they were known, but they are not. At Rothamsted we have adopted various devices for keeping in touch with pure science, one of the best of these being to bring young men and women from the purely scientific laboratories from time to time to take part in our work. This is one example of the "team work" to which I referred in my address as being among the hopeful ways of securing advances in agricultural science, another being co-operation between institutions engaged on different aspects of what may be fundamentally one and the same problem.

Team work makes it possible for the different workers to keep in touch, and to utilise advances made in other subjects. It has other advantages too, for even the wisest of mortals will never see a scientific problem as a whole, but only in part.

E. J. RUSSELL.

Rothamsted Experimental Station,
Harpenden, October 20.

Series in the Spectra of Aluminum and Magnesium in the Extreme Ultra-Violet.

PASCHEN (*Ann. d. Phy.* 71, p. 152, 1923), in his investigation of the spectrum of doubly ionised aluminum (Al. III.), and Fowler ("Series in Line Spectra," p. 120), in his study of ionised magnesium (Mg. II.), have pointed out the type of series relations which exist in these substances, and have arranged many lines to conform to them. In a study of the spectra of both aluminum and magnesium in the extreme ultra-violet, under various forms of excitation, I have recently observed certain lines which appear to be higher members of some of the series discovered by Paschen and by Fowler; Millikan has already identified the two strongest, but the remainder seem to have escaped observation. The wave-lengths and the series to which these lines belong are given in the following tables.

Al. III.

$3p - md.$			$3p - ms.$			$3s - mp.$		
Obs. λ Int.	Calc. λ	*m.*	Obs. λ Int.	Calc. λ	*m.*	Obs. λ Int.	Calc. λ	*m.*
891·9 (1)	892·0	4	855·0 (3)	855·02	5	696·0 (6)	695·8	4
893·8 (2)	893·9		856·7 (4)	856·76			696·2	
			725·7 (1)	725·6	6		560·3	5
			726·7 (2)	726·8		560·3 (3)	560·4	
						511·1 (1)	511·2	6

Mg. II.

$1s-m\pi$.		
Obs. λ Int.	Calc. λ	m.
1240·1 (4)	1239·9	2
1240·5 (4)	1240·4	
	1026·0	
1025·9 (2)	1026·1	3
946·6 (1)	946·7	4

The lines in aluminum were obtained with the vacuum spark and also with a condenser discharge in an atmosphere of helium at about 1 mm. pressure. The magnesium lines were most strongly excited by an arc of 40 volts and about 10 amperes operated in a high vacuum by means of a trembler device.

The numerical values of the wave-lengths should be correct to at least two-tenths of a unit.

It must be admitted that both Millikan and Simeon list a line at λ560·5 which they credit to carbon. The line at 1025·9 in magnesium might perhaps be ascribed to hydrogen were it not for the extreme weakness of the hydrogen line at λ1216.

The persistence of impurities, especially when high voltage excitation is employed, introduces uncertainties which cannot well be eradicated. But in my judgment, the structure of the spectra and the close agreement between observed and calculated values justifies the identifications shown in the tables.

THEODORE LYMAN.

Jefferson Laboratory, Harvard University,
October 7.

Active Nitrogen.

PROF. M. N. SAHA and Mr. N. K. Sur, in an article which has just appeared in the *Philosophical Magazine* (48, 421, Sept. 1924), present a theory regarding the identity of active nitrogen which coincides in certain respects with that advanced by me last December, in a paper read before the American Physical Society (Abstract, *Physical Review*, 23, 294, Feb. 1924). Since this paper has not yet been published in full, and since there are important points of difference between the two theories, it seems advisable to present here certain of the details.

Active nitrogen was discovered in 1900 by Prof. E. P. Lewis (*Astro. Jour.* 12, 8, 1900) and was found by him to have a characteristic spectrum (*ibid.* 20, 49, 1904). It is now known without question, due to the work of Fowler and Strutt, that the α-group bands of this so-called afterglow spectrum are merely a few bands belonging to the First Positive Group of nitrogen, with, however, different relative intensity. The great majority of the bands of this group are definitely absent. Since we now know that all band spectra are due to molecules, and since various methods of investigation have proved beyond reasonable doubt that the First Positive Group is due to the neutral N_2 molecule, it follows inevitably that the emitter of the α-group bands is some form of the neutral N_2 molecule. In this letter I confine the term "active nitrogen" to the emitter of these α-group bands.

My investigation of the band spectrum of nitrogen, in the paper just mentioned, gave a partial indication of the exact form of the molecule responsible for this emission. The strongest band in each of the four groups forming the so-called α-bands corresponds, in the case of emission, to a transition from a molecular vibrational state indicated by the quantum number eleven. In a less accurate way we may speak of the molecule as possessing in the initial state eleven units of vibrational energy. The bands on either side of this strong band correspond to ten and twelve units. All other initial vibration states are entirely, or almost entirely, lacking.

It therefore seems evident, for reasons which will not be disclosed until we know the exact structure of the molecule, that the particular state of electronic excitation corresponding to the initial state of the molecule when emitting the First Positive Group bands, is *metastable*, for ten, eleven, and twelve (especially eleven) units of vibrational energy. The amount of rotational energy is seemingly immaterial. Saha and Sur do not assume a metastable condition, although to me this assumption seems vital. Active nitrogen is *formed* in the electric discharge, and then under the proper conditions diffuses out into a side tube where it may exist for some time (thirty seconds or more), *gradually* changing back to the ordinary nitrogen molecule with the emission of the α-group bands. Because of its excess energy, due to electronic excitation, it is chemically active, and in the presence of impurities it easily forms compounds or produces other excited atoms and molecules, as discussed by Saha and Sur, and also by Dr. Mulliken (NATURE, 114, 349, Sept. 6, 1924). Metastable conditions such as this are now commonly assumed to explain the origin of certain band spectra, such as the band spectrum of the helium molecule.

While the amount of vibrational energy in the active nitrogen molecule seems therefore known, the same statement cannot be made in regard to the amount of available electronic energy. The various major electronic energy levels of the neutral N_2 molecule, as calculated by the author, are given in Fig. 1, where the most stable state is on the right. These levels (X, A, B, C, and D) represent merely the electronic excitation, with no vibrational or rotational energy. B′ represents state B with the addition of eleven units of vibrational energy, where B′ − B = 17,148 (in frequency number). The frequency of the "origin" of the Fourth, Second, and First Positive Groups is thus represented by the lengths D − B, C − B, and B − A respectively, while the strongest bands in the α-group are represented

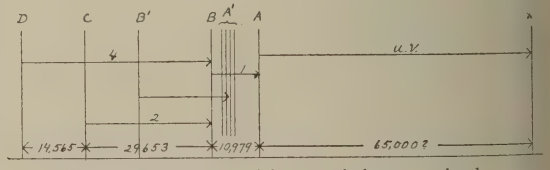

FIG. 1.—Energy levels of the neutral nitrogen molecule.

by B′ − A′, where A′ represents the A state with 9, 8, 7, and 6 units of vibrational energy, and correctly lies on both sides of B.

At the present time, experimental evidence points strongly to the conclusion that A is not the stable state of the molecule, but that there is another group of bands in the ultra-violet, connecting A with the true stable state X. It has not yet been possible definitely to identify such bands by quantitative agreement with the set of vibration levels connected with A (as illustrated by A′), but Dr. J. J. Hopfield is now investigating this matter experimentally, and has just obtained a beautiful plate showing a large number of bands, apparently constituting several distinct groups. One of these lies in the region indicated by A − X in Fig. 1. It is known that the ionisation potential of the neutral N_2 molecule is close

·7 volts, and since D – A equals 55,200 (=6·8 t, it is evident that A – X must be less than ten

Prof. E. P. Lewis has directed my attention e great experimental difficulty in obtaining the th Positive Group, discovered by Fowler and t. There is evidently a very narrow range of imental conditions under which it appears. is in agreement with the above diagram, where s only two volts from ionisation.

e maximum available electronic energy of active gen is therefore given by B′ – X, and since A = 28,127 (=3·5 volts), while A – X corresponds ably to about 8 volts, B′ – X is equivalent to t 11·5 volts. Saha and Sur assume that active gen is merely a nitrogen molecule excited with volts energy. This assumption precludes the bility of emission of the α-group bands, and s no explanation of the distinction, in intensity ibution, between the α-group of the afterglow the ordinary First Positive Group.

of. E. P. Lewis, at the time of his original dis- ry, stated that a trace of oxygen was necessary he formation of the afterglow. After a prolonged ssion, in which various investigators participated, as mutually agreed that this statement was ct, except that *any* electro-negative substance uced an analogous effect (enhancement of the glow). Now a molecule can remain in a meta- le state only in the absence of any disturbing . Under the conditions obtaining in the region re the afterglow appears, the chief disturbing is that caused by the collision of other molecules f free electrons with the metastable N_2 molecules. tron collisions would be particularly effective in ing a reversion to the stable state. But Prof. is has shown the presence of some free electrons he afterglow (NATURE, 111, 599, 1923), and has gested that this trace of electro-negative substance eeded to "clean-up" the electrons in the side e, and thus to prolong the life of active nitrogen. terms of the present theory we would say that t active nitrogen molecules revert to the stable n in the main portion of the discharge. Some fortunate enough to diffuse into the side tube, re under suitable conditions they could exist finitely. With no electro-negative element sent there is sufficient concentration of free trons to cause the immediate reversion of the ve nitrogen, before it has had time to diffuse any reciable distance, and possibly directly to the le form X, with the emission of high-frequency ds. On the other hand, any excess amount of an tro-negative substance acts in a similar disastrous nner upon the metastable molecules.

Even with the small necessary amount of oxygen, re will be some collisions between oxygen molecules l active nitrogen molecules. We may assume t this results in the formation of a special form of tronic excited NO molecule which reverts to the esumably) stable form of NO with the emission the β-bands, discovered by Prof. Lewis in the after- w. Dr. Mulliken, to whom I am indebted for ny suggestions in this matter, has suggested that s type of electronic excited NO may be metastable. this is true, we have, in one sense, another form of ctive nitrogen." But, as stated, it seems prefer- le to reserve the term for the emitters of the α-group nds. We may assume, further, that more usual pes of union of oxygen and nitrogen may produce different form of electronic excited NO which erts to the stable form with the emission of the ands (Third Positive Group). The β- and γ-bands em, from certain mathematical relations, to have common final state, and if so must be due to the ne molecule. This question is discussed by Dr. Mulliken (*loc. cit.*), who independently found this common state.

In conclusion, then, I assume that if the emission of any group of afterglow bands is a primary phenomenon, the emitter must be a metastable molecule, which may be called "active." This certainly seems true as regards the α-group. But if the emission is a secondary phenomenon, occurring as a consequence of "second-type" collisions with a metastable molecule, the emitter need not be metastable. It does not seem possible, at this time, to state any very definite conclusions as to the mode of excitation of the β- and γ-groups.

RAYMOND T. BIRGE.

Physical Laboratory,
University of California,
September 25.

The Shrinkage of Gelatin.

IN a letter in the issue of NATURE for October 18, Prof. D'Arcy Thompson makes the attractive suggestion that the curved surfaces generated when cylinders or simple polyhedra of gelatin gel are allowed to dry (described by me in *Koll.-Zeitschr.* 35, p. 67, 1924) bear a strong resemblance to the minimum surfaces over the corresponding boundaries. Such minimum surfaces are easily produced by stretching soap films over openings or wire frames of the desired outline.

The suggestion receives additional support from the conditions prevailing in drying bodies of elastic gel: the edges dry more rapidly than the faces, providing a framework which is almost rigid when drying has progressed sufficiently, and the faces dry more rapidly than the interior. A skin is accordingly formed under stresses not unlike those to which a soap film stretched over an opening and exposed to pressure on one side is subject. Nevertheless the resemblance is approximate only, as can easily be seen when the contours of the two types of surfaces on planes parallel to the boundary are examined.

The curved surfaces which form when cubes or regular tetrahedra of elastic gel are dried have the very peculiar property that *their contours on planes parallel to the original face are rectilinear polygons similar to the original boundary* over the greater portion of the surface. This property was found experimentally, by actually drawing the contours on the dried polyhedra. Fig. 1 shows the body

FIG. 1.

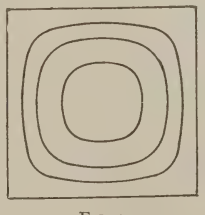

FIG. 2.

which results when a cube of 15 per cent. gel is dried at room temperature, with three contours drawn on it. It is a simple matter to express this condition analytically: if the profile curve, say, on the diagonal of the cube face is of the form $z = F(r)$, the equation of one quadrant of the surface in cylindrical co-ordinates must be of the form

$$z = F[r(\cos\theta + \sin\theta)],$$

where the r, θ plane is parallel to the original face, and $\theta = 0$ for one diagonal.

Since the equation of the profile is not known (it is very approximately a simple sine curve), the equation of the surface and that of the corresponding minimum surface over the square boundary cannot be compared directly. The surface can, of course, be easily produced by blowing up a soap film over a square opening, but the determination of contours on such a film calls for somewhat delicate experimental arrangements (cf. Griffith and Taylor, J. Inst. Mech. Eng., No. 1, 1918, p. 755). The error is probably not great if a very thin rubber membrane is blown up with low pressure, and I have carried out this experiment and drawn the contours, which are shown in Fig. 2. They are curvilinear and approximate to circles the more the apex of the surface is approached. While there is a certain resemblance between the surfaces produced by drying polyhedra and minimum surfaces over the same boundaries, the two are, therefore, certainly not identical.

A rational treatment of the problem does not appear hopeful, as two questions of very great difficulty are involved. It would be necessary to find the law according to which the water content varies from place to place, and then to deduce the conformation from the relation between water content and the elastic constants. Even the latter are known very incompletely; over a moderate range of concentration Young's modulus is approximately proportional to the square of the gelatin content (Leick, 1904), but this relation holds up to about 45 per cent. only, whereas air-dry specimens have a gelatin content of 80 to 85 per cent. EMIL HATSCHEK.

London, October 21.

The Causation of Cancer.

THE notice which appeared in the issue of NATURE of October 4 of my book, "Cancer: How it is Caused, How it can be Prevented," contains several misstatements which I must correct. The reviewer puts into my mouth the statement that "cancer is due to constipation and lack of vitamins" as a summary of my teaching, although I have stated in every chapter that cancer is due to chronic poisoning and to vitamin starvation, a totally different matter. The reviewer also states that "Almost the only authorities he quotes are surgeons" and "Their statements [are] mostly from the general press." From the bibliographical index at the end of the book every reader can see that the majority of my witnesses are physicians, physiologists and chemists, although there are a great many surgeons. Besides, my quotations are not "mostly from the general press" but from the leading scientific periodicals, as will be seen by reference to the section "Periodicals Quoted," contained in the bibliographical index.

Further, the reviewer says that I "put forward the pious belief . . . that cancer is a disease of civilisation," giving the impression to readers that I have drawn upon my imagination. In reality, the fact that cancer is a disease of civilisation is fully proved by the pronouncements of more than a hundred physicians practising among uncivilised nations, whom I have quoted and to whom I have referred. The reviewer's statement that I recommend "eating raw food and roots like the beasts in the field" for preventing cancer is another distortion. I have recommended a diet rich in vitamins and in roughage, a diet consisting largely of wholemeal bread and plenty of raw fruit and salads.

In conclusion, the reviewer states that my book "will do much more harm than good." I have received hundreds of letters from cancer sufferers both medical and non-medical, informing me that their case cancer was undoubtedly caused by chron poisoning and vitamin starvation, and I am receivi every day letters from readers, telling me that the health has been vastly benefited by the adoption the diet recommended in my book.

J. ELLIS BARKER.

Albion Lodge, Fortis Green,
East Finchley, N.2,
October 13.

I HAVE no desire to embark on a controversy wit Mr. Ellis Barker in a scientific journal like NATURE though I have behind me thirty years' study of ne growths. His hymn of hate above is no doubt a reli of the time when, as "Who's Who" informs us, h "devoted his literary career, ever since 1900, t warning England of the danger of a war wit Germany and to urging military, naval, and economi preparation." Mr. Ellis Barker may be an authorit on the foundations of Germany, British socialism tariff reform, and the Motherland and Empire, bu we must be pardoned if we cannot accept him as th authority on the cause and prevention of cancer Since the receipt of his onslaught, I have re-read hi book and my considered opinion is that it is ridiculous Mr. Ellis Barker must know perfectly well that th review of his book in NATURE is milk and water com pared with the vitamin-free strong potions that hav been administered to him on the subject of his boo by the *Lancet* (1924, ii. 70), the *British Medical Journa* (1924, ii. 324), *Science Progress* (1924, 328), *America Journal of Public Health* (1924, xiv. 787), and th Journal of the American Medical Association (1924 lxxxiii. 784). I do not, in fact, remember having read in the medical press such wholesale condemna tion of any book. THE REVIEWER.

The Choice of Wave-lengths for Achromatism in Telescopes.

MY attention has been directed to Prof. Townsend Smith's letter in NATURE of October 11, p. 536, in which he refers to my paper in the Transactions of the Optical Society. I entirely agree with the very useful curves he has drawn.

It would not be difficult to try the combination of the red lithium line and the F hydrogen line which he suggests, for no new measurements of refractive indices need be made.

In a paper, "The Existing Limits of Uniformity in Producing Optical Glass" (Roy. Soc. Proc. A., vol. 87, p. 190, 1912), a table of the refractive indices of twenty-seven different optical glasses is given, in contiguous columns in the order of their mean dispersions. Indices for both the lithium and the F line run throughout. Since the optical properties of the glasses in adjacent columns very closely resemble one another, interpolation for another glass, the mean dispersion of which lies between them, is easy.

Two later papers with similar tables have been published (Roy. Soc. Proc. A., vol. 91, p. 320, 1915, and vol. 100, p. 624, 1922), and they give a choice of fourteen additional glasses from which to interpolate.

At the end of his letter Prof. Smith refers to 546$\mu\mu$, the mercury line, as being not far from the correct minimum for the D and E curve. This is so, and some years ago I computed an object-glass where focal lengths for D and E were equalised with this mercury line for shortest wave-length, and it was afterwards constructed. Although definition proved

cent, the greens, blues and violets were distinctly
ed at the expense of the oranges and the reds,
ffect being slightly garish.
ter I computed an exactly similar combination
the exception that 561$\mu\mu$ now took the place of
, and the correction of all errors due to curvature
made for that line. This second object-glass
then constructed, and it was found that the
t referred to had been entirely removed.

J. William Gifford.

urrian, Mullion,
S. Cornwall,
October 13.

"Ship-designs" on Prehistoric Egyptian Vases.

my friend Dr. Forbes has raised once more a
ion about the Egyptian ships, without quoting
ecisive examples, I would ask to supplement his
in Nature of October 4, p. 499.
the Gebel Arak ivory knife-handle is figured
sult of a naval fight between two types of ships
d opposite to each other, with the drowned men
between them (*Ancient Egypt*, 1917, p. 27).
Egyptian ships are of the same form as those on
Hierakonpolis wall painting (*Hierakonpolis*, lxxv.),
the two cabins and gangway between, and a top
er alike in both. The Hierakonpolis painting
shows a black ship with very high prow, like
of the enemy on the ivory, and like one with a
e sail on a vase in the British Museum. Each
ne Egyptian ships has the painter rope and
h at the prow, like that used to catch the wind
ne Swedish and Guinea coasting vessels. At
tern is the steersman holding the large steering
le. It does not seem possible to deny that these
ips.
w these vessels are exactly of the type of the
of the pottery paintings. The same outline,
s, space between them, and ensign at the hinder
, tying-up rope, and branch in the prow. If
are ships, then the sticks projecting below
are oars. The only argument for fixed forts is
the flamingoes indicate lagoons, but then most
itive waterways are bordered with lagoons.
cannot see how any idea of fixed habitations can
d with all these evidences of shipping, glad as
y be of any explanation by an eminent zoologist
t the living forms. Flinders Petrie.

Cannon Place,
Hampstead, N.W.3.

Microseisms and Storm Forecasts.

E value of the seismograph as a detector of the
severe type of cyclonic storm in the Bay of
al was recognised some fifteen years ago by
C. W. Peake, then Meteorologist at Calcutta.
n I left the Observatory in 1922 it had become
ar routine for the Omori charts to be examined
microseisms during the writing of the Daily
ther Report, whenever pronounced symptoms of
rious storm existed in the south of the Bay.
-marked microseisms invariably confirmed other
ence in the case of the early stages of dangerous
ones, and were sometimes noticed when the
n centre was so much as 1000 miles south of
utta.
do not, however, recall any instance in which
oseisms were associated with ordinary rough
her or with an advance of the monsoon, but
bly a close scrutiny of the charts on the appro-
e dates would reveal the phenomenon. The
ral view in the observatory was that the seismo-
h ignored anything but a moving area of *excep-tionally* low pressure, and for this reason there is some doubt as to whether the obvious explanation that such microseisms are due to ordinary surface waves is the correct one; the large surface wave presumably always caused by the progression of the cyclone as a whole may, however, play a part in the production of the earth tremors. In any case, Dr. Banerji's suggestion (Nature, October 18, p. 576) that the vibrations he observed may be used in forecasting the date of arrival of the monsoon on the Malabar coast, is very interesting and should prove valuable.

E. P. Harrison.

H.M.S. *Vernon*,
Portsmouth.

Flight of Birds.

Some observations which I made on the flight of gulls two years ago on a trip to the Gambia were confirmed lately by observations in the Irish Sea and Atlantic. With the vessel (some 300 tons reg.) proceeding N.N.E. in a steady fresh E.N.E. wind, the gulls flew head to wind, keeping practically the same position in or over the stern of the vessel, apparently on motionless wings and with little or no updraft of air. While keeping head to wind they advanced *sideways* with the vessel going about 9 knots. I noticed the same attitude of gulls when the wind was quite ahead and the birds as usual, flying head to wind. In the latter case the birds seemed to have less difficulty in maintaining both their position and motionless attitude.

In practically identical weather, but with rather less wind force, I was surprised, on another day, to see gulls flap their wings continuously, a difference of behaviour which seems curious.

When up the Gambia River, on a calm day, I noticed a large heron flying along a few feet above the river surface. It gave a few flaps of its wings, then planed along some distance, then a fresh flap and again a plane, and so on for some distance but maintaining the same level. Recently, I constantly observed gannets fly in the same way.

David Wilson-Barker.

The Fluorescence and Channelled Absorption Spectra of Bismuth Vapour at High Temperatures.

Continuing our previous work on the absorption of light by bismuth vapour, we have found that the vapour exhibits, at a temperature of about 1300° C., an absorption spectrum composed of a very great number of bands presenting a fine structure, and extending from λ6500 to λ4500. We have photographed more than 400 bands in this region. These bands shade off towards the red end. At this high temperature, it is found that the vapour emits a fluorescent radiation orange-yellow in colour, and we have succeeded in photographing the fluorescence spectrum of the vapour at this temperature, containing about 24 bands ranging from λ6600 to λ5050. Hitherto bismuth has not been shown to possess either the fluorescence or channelled absorption spectrum in this region. Full details of the experiments, together with the photographs of the fluorescence and channelled absorption spectra of the vapour at this high temperature, will be published shortly.

A. L. Narayan.
K. Rangadhama Row.

Research Laboratories,
H.H. The Maharajah's College,
Vizianagram.

Health and Physique through the Centuries.[1]

By Dr. F. C. SHRUBSALL.

IN his presidential address to the Section of Anthropology at the Winnipeg meeting of the British Association, Prof. J. L. Myres asked the question "What happens to Englishmen in city 'slums'?" or, in other words: How are the peoples of Britain adapting themselves to modern conditions? Are these conditions producing modifications in the racial constitution and qualities of the nation? The matter is one of importance to the older country, for more than three-quarters of the population now reside in urban districts, and to the newer, since in the course of time industries must concentrate in favourable localities and close aggregates of population necessarily arise.

The trend of events can be followed in outline from demographic data from about the fourteenth century, though the records are scanty until the nineteenth century. The main factors are urbanisation and industrialism, the combined effects of which can be seen best, though in an exaggerated form, in those individuals who follow certain trades, such as the textile industry, which associate dense aggregation with, even at the best, unhealthy conditions of occupation.

Indoor trades and factory life introduce very different physiological conditions from those under which the young peasant has his being. These factors tend to depress the vitality of the incomer from the country, while those born in the industrial township would be exposed to urban conditions throughout early as well as adult life, and have the further handicap in infancy of the lack of care inevitably associated with the factory employment of the mothers.

In addition, selection may in time sensibly modify the distribution of the various racial elements of the population. Psychological factors, too, come into play, for some types seem to prefer the freer life of the open spaces and leave a district as it becomes more densely settled; while others, who have no love or aptitude for solitude, migrate into the growing towns. The early settlers of the North American continent were drawn largely from areas occupied by Nordic peoples whose early history was that of hunting and fighting communities. As the eastern edge of the continent became settled, it was this type that was largely represented in the pioneers of the West.

The most alarming data in regard to the position in Britain come from the report of the Ministry of National Service on the findings of the recruiting boards during the last years of the War, but a reassuring comment was made by the Commissioner for Yorkshire, who pointed out that grading for military purposes must, in many essentials, differ from grading in respect to fitness for civilian life, which, after all, is the factor of most permanent importance to a nation. No previous data had given any idea of the extent of age changes in efficiency, though it was well known that the period of maximum efficiency in active games was the ages under thirty. It is therefore not surprising that the numbers fit for severe strain should fall off after that age or that relatively few over forty should be fit f effective military service. There is no reason to thi that this is in any way a new condition associate with urbanisation, or that a similar census in pa centuries would have yielded any better result Another and more serious criticism of this report as a accurate survey of the whole state of the populatio of Britain rests on the fact that it was only undertake after some years of war, when the physical pick of th nation had already voluntarily enlisted.

The more valuable data are contained in the recor of youths born in 1900. The proportions of Grade varied from 80 to 85 per cent. in rural areas, more tha 75 per cent. in mining areas, 72 per cent. in the suburl around London, down to 49 per cent. in the crowde industrial areas of Lancashire.

There is nothing in the statistics to suggest that th British people have degenerated more than othe nations. The German pre-War figures showed 72 p cent. fit or prospectively fit for service and 28 per cen less fit or unfit for service, with the same contra between the rural and urban, the agricultural and th textile areas, as is noted in Britain.

Actual data on stature are very sparse in the repor of the recruiting boards. A large number of the adu male population examined as conscripts in 1918 ha statures between 64 and 67 inches, but the averag figure obtained has little significance as an index the whole pre-War population, since a large proportio of the tall stock had already enlisted. The lowe statures were found among the casual labourers an the textile workers, who had been subject to ba conditions of environment.

The returns from the School Medical Service sho that stature is, on the whole, greater in England an Wales to the south of a line drawn from the Severn t the Wash, with an extension northward to includ Lincolnshire and the East Riding of Yorkshire; i addition, scattered areas containing many tall childre occur in Westmorland, on the coast of Cumberlan in the far north of Lancashire, in the hilly districts Staffordshire, and in Merioneth. This line of demarca tion clearly marks off the industrial from the rur districts, though it also largely coincides with areas former Saxon, Danish, and Norwegian occupation. Th children in factory towns and mining areas are i general definitely shorter than those in rural district The best physique is found in the great public school then in order come other secondary schools, the trad schools, and the ordinary elementary schools; thes correspond pretty well to the leisured and professiona the commercial, the artisan, and the factory an labouring classes respectively. The stature of th children from the better-class schools, many of whor present Nordic traits and all of whom have bee brought up in a favourable environment, is equal t any in the world. The general average for all type of schools is, however, below that of the children British descent in the Dominion or the Commonwealth The advantage of the latter supports the opinion tha the emigrant stocks from Britain contained a larg

[1] From the presidential address to Section H (Anthropology) of the British Association at Toronto delivered on August 7.

rtion of Nordic elements, and also suggests that ildren flourish under the new environment.

neolithic times, so far as can be gleaned from al remains, the average stature of adult males bout 63 inches with a few taller individuals inter- d, who were perhaps of the ruling caste; the is averaged about 66 inches, the Norwegians and s were a little taller. Throughout the medieval l, stature remained little affected so far as can lged from clothes, implements, and armour, which t suit the larger number of the present-day people would indeed be too small for the better built. e eighteenth century there were many recruits e stature was only about 63 inches.

cords of children of Lancashire operative and ring classes, taken in the second quarter of the eenth century, when compared with similar figures e present day, show little change until the last ears. Since the initiation of the School Medical ce, it has become evident that a gradual improve- is in progress. In London elementary schools has been a gain of a full half-inch in stature since while in the public schools average gains of an or more are recorded. The changes in weight are more general and significant.

mparisons which have been made between children have suffered from illnesses and those who have none of importance show the greater stature of tter class; many children fail to attain their full re on account of morbid factors which may act e growing bones directly, as in rickets, or indirectly gh malnutrition resulting from infectious ailments, rhs, or actual privation.

king a more general survey, the health of a people r varying conditions may be measured by the tion in the duration of life, which appears to have ased steadily from the earliest times. The great has been that more now live to middle age or nd. The expectation of life varies from class to much as does physique, being greater for the ssional classes than for the agriculturist, for the ulturist than for the miner, while the latter in is a better life than the tailor or the textile worker. so seems that there is a greater expectation in those s which, at any rate until recent times, were pied by a predominantly Nordic population.

eneral health has often to be estimated from the rds of mortality, though it must be remembered morbidity is much greater than mortality and that fter effects of injury or disease may long affect the sique of the sufferer. Lethal agencies are some- s local, sometimes widespread in their action, and at times exert a selective action on the population cted.

ar in early culture might occasionally wipe out a le population, but more often the skilful and strong ived; in modern war the selection favours those se physique does not permit of active military ice and is thus opposite in tendency. War acts e lethally through the social disorganisation, and consequent famine and disease, which follow in its n, than through any casualties in the field; from e direct experiences on its own soil, England has n singularly free since the Norman period. Thanks aps to the great demand for labour and to the separation allowances, as well as to the seat of action being abroad, the recent War has exerted no obvious harmful effects. The children have been well nourished and there was no great increase of defective children, such as had been anticipated by some, even in the areas most exposed to air raids. There was, it is true, an increase in the number of children who were trouble- some and educationally backward, but on examination it was clearly seen that these features were not due to innate characters but to truancy and lack of discipline during the absence of their fathers.

Famine took its toll in Western Europe in the medieval period, but England was the country in which the mass of the people soonest attained to fairly constant comfort. This was a great contrast to France, which repeatedly suffered from long years of famine. Harrison in his "Description of Britain" quotes a Spaniard in Queen Mary's day as saying "These English have their houses made of sticks and dirt, but they fare commonly as well as the king." In general any morbid influences on nutrition arose rather from a seasonal scarcity of certain essential articles of diet than from famine in the ordinary acceptance of the term.

Disease, throughout the historic period, must have been the most lethal of all the morbid agencies; there is nothing to suggest that there are important diseases to-day from which our ancestors were free. On the other hand, certain of the scourges of our ancestors have practically disappeared, especially some of the infectious diseases. Leprosy and plague long ago ceased their ravages, typhus and famine fever vanished, save for isolated cases in later Victorian times, enteric fever has lessened nearly to the vanishing point, and even infantile diarrhœa is becoming less year by year. Most, if not all, of these diseases may be communicated by animal agencies, either by direct inoculation from bites or by secondary contamination. The louse, the bug, and the flea, common until recent years, are succumbing to the newer tradition and meaning of cleanliness which has followed universal education, the medical inspection of scholars, and the action of public health authorities; the fly, an indirect agent, is being eliminated by improved sanitation and the gradual disappearance of horse transport in our cities. As the changes proceed more rapidly in the towns the approxi- mation of their health conditions to those in rural areas follows.

The mortality in early years was very high; thus in 1754 the deaths in London of children under two years of age were 45 per cent. of the deaths. Infant mortality has oscillated around 160 per 1000 until 1900, since when it has fallen to 60 per 1000 in 1923. A great part of the reduction has been in deaths due to infectious diseases and especially to diarrhœa; there has been little or no change in the rates from congenital defects or developmental disorders, which have remained relatively unchanged in all classes of the community, so that this lethal selection against the naturally unfit remains as rigid as ever.

Mortality in the early years of life is greater in the cities than in the small towns and in these than in the rural areas; it is greater in the north than in the south for all classes of the community, but it must be noted that with the great fall during the present century

the gap between urban and rural areas has been closing. This again suggests that education and a higher standard of personal hygiene are important factors, for the country is always more conservative in its actions and beliefs.

The mortality of the infants of agricultural labourers is less than that of those of any other class of manual workers, not only so far as diarrhœal diseases are concerned—here, perhaps, they have better chances of obtaining fresh milk—but also from measles, tuberculosis, and respiratory diseases generally. Some of the difference may be due to the rural child, on the average, being older than the townschild at the time he is attacked by infections; for, whereas infantile infections spread through towns about every second year, in the country districts there may be an interval of five years between periods of epidemic prevalence. The infant mortality among textile workers is especially due to diarrhœa, which may be ascribed in many instances to artificial feeding during the mother's absence at the mills. The children of this class also die notably from congenital malformation and prematurity, which might naturally have been attributed to the mothers working until a late stage of pregnancy, were it not that the mortality from these causes is even higher among the children of miners, whose womenfolk seldom work outside their own homes. On the whole the evidence goes to show that morbidity, and especially infant morbidity, is closely associated with the aggregation of population, but that in recent years improved standards of social or individual hygiene and comfort have done much to neutralise specific causes of ill-health. It may also be taken as proven that such ill-health is the greatest cause of stunting of physique. As in the past the countryside has been freer from these morbid influences; the countryman has been the physical superior of the townsman, comparing class with class.

There are three main ways in which the growth of towns and of the industrial system has prejudiced the health and thus the physique of the nation: adverse conditions of work, which had little influence prior to the eighteenth century, unhygienic housing, and bad feeding, which in varied ways have exerted their effects throughout a large part of human history. Some of these would be peculiar to the town, others would fall indifferently on town and country, and on all social classes save perhaps the very wealthiest, though even they could not entirely escape. The contrast is less vivid than would appear at first sight: the country child can get fresher food, it is true, but less of it perhaps, owing to the lower wages of his parents, though he often eats margarine, the butter being sold in the towns; he gets fresher air outside but not indoors, since the country cottage may be as dark, ill-ventilated, and overcrowded as any in a city court.

The greatest change in the conditions of work was the rise of the factory, involving long confinement in monotonously ventilated rooms, as opposed to work in the open at the door of the home. The early factory was an extension of the home. The introduction of water and steam driven machinery aggregated the populations into the northern towns which arose near the sources of the power, and put a premium on the employment of children who could then do work whi formerly required a man's strength. In recent ye the general hygiene of the worker, together with t removal of industrial risks, has made enormous stri the result being apparent in the falling death rate a the healthier children.

In early days the English dwelt scattered throu woods and marshes; in medieval times they began flock to the towns in which the sanitary conditio were bad; during the industrial revolution the aggreg tion of houses and the pollution of the air great increased and produced their well-known evils, thou the sanitation of the individual houses was, in sor respects, no worse than before.

Sedentary occupations in still warm atmospher have the effect of lowering the general metabolism a of reducing the desire for food, thus producing a simil effect to actual privation and affecting even the we paid worker. Acting through long periods during t growing time of life, such factors whenever they ar may stunt growth as well as predispose to illne Many dietaries which appear satisfactory on a me caloric basis prove failures owing to the lack of vit elements. The industrial worker is doubly han capped; he not only loses his appetite and tak scarcely enough to provide the necessary energy f his work, but also, too often, he takes even that the form of margarines and canned foods which not supply adequate vitamins. If, as is probabl physique suffered with the concentration of t population in the industrial areas, no small part ma have been played by the confinement in a relaxi atmosphere and the substitution of inert for live food The worker who emigrates to more rural surroundin reverses these conditions and, if young enough, recove part of his lost physique, and in any case his childre not being handicapped, fulfil their true potentialitie With feeding as with housing, though the industri age brought its own defects, yet the contemporaneo increase of civilisation provided the remedy for son of the previous evils, such as those arising from ir perfect methods of food preservation. The curing the best was very imperfect, and the diet of the poor classes would be the semi-putrid sides of bacon, mutto or beef. Indeed, it was enacted that such should l given to the outcast by the Scottish Parliament Scone in 1380. "Gif ony man brings to the mark corrupt swine or salmond to be sauld, they sall be take by the baillie and incontinent without any questio sall be sent to the lepper folke; and gif there be n lepper folke, they sall be destroyed alluterlie."

Modern medical inspection and treatment are fa counteracting the chief causes depressing the healt and physique of the children, and are also dealing wit contributory secondary factors, such as defective teet and other foci of chronic sepsis, verminous condition and unsuitable clothing. No one who compares photo graphs of present-day children with their predecesso of the 'seventies can doubt the change. It is significan that the town is now gaining over the country and tha London children are now second to none. The treat ment schemes did not come into force until just befor the War, and affected almost exclusively children wh did not reach military age in time to appear befor recruiting boards, so that the benefits of the syste

not be brought out in the report of the Ministry ional Service. In this direction the future seems

re remains the gap between the school and adult An experienced Scottish recruiting board reported ing off during adolescence both in the agricultural he industrial classes. With any extension of ilies for apprenticeship or trade instruction, with tunities for the further treatment of ailments, though these be of a voluntary character, much be gained. Moreover—since the use made of facilities would depend on the mentality and ter of the individual—the youth with the best and good will should gain the advantage and be red in his prospects of a successful marriage, gh which he could transmit these qualities to r generations.

ning to the genetic aspects of the subject, it is that the future of the nation depends on the uction of two somewhat opposed processes, repro- ve and lethal selection. Fecundity is a heritable and parents who themselves are members of families tend to produce many offspring who, in turn, are similarly prolific. Lethal selection, on ther hand, counteracts this tendency in that the nds of a large family reduce the chances of the its protecting themselves or their offspring, since vailable care has to be distributed over a larger er. It will be noted that the shorter the intervals een successive births, the higher is the rate of t and child mortality.

at reduction in fertility has been of long standing ikingly illustrated by Crum's study of the New and genealogies, in which he finds a progressive tion in the size of the family and an increase in roportion of childless marriages. The differential rate, chiefly due to infant mortality, to some t modifies the initial differences in fertility; the fertility of the agriculturist is largely opposed he low marriage rate, and the relative infertility he upper classes is exaggerated from the same e.

ere appears to be a general impression that the ber of defective individuals, particularly of those ring from mental defect, is greatly increasing. e is little evidence on this point of a comparable re, but it may be definitely said that in London uch increase has taken place during the last fifteen s. The stocks from which defective individuals e are certainly often prolific, but the infant tality is high. Contrary also to popular belief, tally defective individuals do not mate in nearly igh a proportion as the normal. There is some on for thinking that there is a great intermarriage veen defective stocks, and that the actual number uch stocks is in reality quite limited.

here remains one important factor bearing on sique—namely, emigration. Since the early part he seventeenth century the British Isles have sent ad large numbers of the most efficient of their ple, agriculturists and skilled workers of all kinds essed of just the qualities which the nation demands its own physical good. Where these have come n somewhat isolated areas the result has been a dy loss of the best, with the consequent replacement in the next generation by the offspring of an undue proportion of the next best. This—probably the most serious drain to which the nation has been, and still is, exposed—can only be regarded with equanimity on the ground that England's loss is the gain of the daughter nations. The emigrants have been largely of "Nordic" and "Prospector" stocks, seeking a wider scope for their energies, and the result will in the end seriously modify the racial composition of some parts of the British Isles, particularly Scotland.

Summarising the whole survey I would submit that a pessimistic view of the physical or mental condition of the people of England is unnecessary and unfounded. Stature and weight at least are not less than in earlier days. The War showed the possession of powers of resistance to physical adversity that have never been equalled. The general health of the nation is better and the expectation of life longer than ever before. There are no grounds for thinking the physical conditions of any class are worse than that of corresponding classes at previous epochs, even among those persons and classes on whom the adverse conditions of life associated with urbanisation and industrialism have pressed hardest and have been least opposed. The real increase of the unfit is much less than has been assumed from *a priori* arguments. Reproductive selection, which has a tendency to increase the apparently less valuable stocks, is opposed by a lethal selection which has not been abolished, while emigration, from the eugenic point of view, though a real disadvantage to England, has been a source of strength to the Empire of Associated Nations. The dysgenic tendencies of industrialism are being successfully opposed by the higher level of general culture and the awakening of a national conscience, but more especially by the more intelligent care for the children of the nation, in which the application of preventive medicine to education is playing no mean part. The Education Acts, if they have not revealed every child as a potential university scholar, have proved the best of public health measures; while all available evidence points to the intellectual average being equal to that of any other country. Civilisation may be making greater demands on its bearers, but their qualities are neither diminishing nor deteriorating and more and more are fitted to shoulder the burden.

Periodical surveys are necessary to check the changes in the population. Failing more extensive measures, these may be effected through the records of the medical inspection of school children, though in these anthropometric data are but scanty. The matter is of great importance, since it is only on the basis of careful physical and mental surveys that legislation directed towards social and racial hygiene could properly be introduced and rightly justified. The lack of such information has been a great handicap to the discussion of such measures in Britain, and has allowed a freer play to pessimistic views.

None the less, despite all forebodings, it may confidently be stated that the mother nation has remained true to herself and deserves now, as of yore, the encomiums of the "Polychronicon": "Engelond ful of pley, fremen well worthy to pley, fre men, fre tonges, hert fre, fre helth al the leden."

Why Wireless Electric Rays can bend round the Earth.[1]

By Sir JOSEPH LARMOR, F.R.S.

MYSTERY has remained attached to the transmission of free electric rays a long way round the protuberant curvature of the earth, which has recently developed into the greatest sudden practical evolution in signalling since the telephone. The difficulty was already emphasised by the late Lord Rayleigh, as soon as the first signs of transmission across the Atlantic had been detected by the Marconi operators. The effect has been sometimes supposed to be accounted for by a hypothesis that the rays are turned downward by an upper conducting layer in the atmosphere. But conduction, as usually understood, involves dissipation, and thus loss of energy of the rays by absorption; so that a train of radiation travelling along a layer sufficiently conducting to bend the rays could not go far. In fact, by a well-known dynamical principle, if the absorption is small of the first order, the resulting increase of velocity of the train is small of the second order and so of no account for bending rays in a varying field.

There seems, however, to be a sufficient and rather striking cause available for transmission of long waves horizontally round the earth at great altitudes, though the rays travelling at lower heights would be gradually quenched. For the synchronous oscillations of free ions of small mass go on undisturbed by collisions in very high regions of the atmosphere, and have time owing to the long period of the exciting waves to get up high speed and so become important under the influence of the field; much as the electrons in a triode valve have time during the electric oscillation affecting them, or rather in this case during their passage, to get deflected on to the grid. In an extremely tenuous atmosphere, this free ionic oscillation would be almost the sole conceivable deflecting agency. On the other hand, the absorption that would accompany ionic oscillations in ordinary conduction arises from the shortness of the free path, which leads to dissipation, through collisions with the surrounding molecules, of part of the extra energy acquired in the accelerated motion of the ions and thus abstracted from the electric field. When, as above, the period and amplitude of the oscillatory motions of the ions are much shorter than the time and length of their free path, so that the great majority of the oscillations take place without interference from collisions, this loss of energy will be very much reduced. A rough illustration of this principle is doubtless afforded, at the other extreme, by the remarkable penetration of the very short X-rays into light metals. It is not, of course, that conductance tends to become perfect, for then no waves could travel: the influence must be turned on to the dielectric modulus of the medium.

This cause must operate also for long waves travelling in the extreme limits of the atmosphere where the free path is great. The density aloft may be extremely minute: the long swing of the ions can bend the waves. The region in which the aurora borealis is displayed extends up to a height of fifty miles or more, and there the free atomic path for air would be about two centimetres. For radiation of wave-length of kilometre, with oscillating field of amplitude one v per metre and so transmitting $\frac{4}{3} . 10^{-7}$ watts p square cm., the amplitude of the oscillations of fr electrons would be about five centimetres, and f heavier ions it would be smaller inversely as th mass; while the time of oscillation for this length wave is only about a twentieth of the time of the fr path, at this altitude, for a molecule of the air, or quarter of the free time for a hydrogen ion. For electron moving with the speed of thermal equilibriu this time of oscillation would come to ten times t time of its free path at this height; this would entirely excessive and the electron would be an age of strong dissipation, were it not a reminder that t electron passes through the atom each time with b slight derangement of its free motion.

The long free path would in itself tend to augme the degree of ionisation. There must, of course, be many positive ions present as negative; but thou both influence the velocity of propagation of t waves in the same direction, the effect of the massi ones is negligible. It can readily be shown that t result is to reduce the effective dielectric modulus the medium, the value of which is close to unity, $N_0 e^2 \lambda^2 / 2\pi m$, where N_0 is the numerical density the ions of charge e and small inertia m. The amplitu of free oscillation of each ion would be $e\lambda^2/4\pi^2 mc^2$. in a field of amplitude F_0. The velocity of propagati v is increased relatively by the first of these amount which is for the same stratum proportional to t square of the wave length λ. The curvature of t horizontal rays in any stratum is equal to $d \log v/d$ the rate of relative increase of the velocity upward which is here $\frac{e^2\lambda^2}{2\pi m} \frac{dN_0}{dh}$. The stratum of transmissi to great distances is the one for which this is exact the same as the curvature of the earth, namely, $\frac{1}{2}\pi . 10^{-7}$ For electrons this gives dN_0/dh equal to 10^{-5}, f hydrogen ions 1700 times this; thus if this adaptati of curvature applies to a sheaf of rays extending ov the height of as much as a kilometre, N_0 need n mount to more than one electron per cubic cm. for th wave-length of one kilometre, whereas the number the atoms would still be as much as 10^{14} per cubic cr at the height of fifty miles, which gives a sufficient fr path for material ions. For hydrogen ions, N_0 woul have to be increased to $2 . 10^3$ per cubic cm., whi the amplitude of oscillation would be reduced 17 times so that the effective stratum need not be high; if free electrons also are present in number in thermal equilibrium, they would introduce dissipa tion of the rays passing at levels considerably high than this rough illustrative estimate of fifty miles, were it not that their motion, more potent on accour of their smaller mass, is so slightly deranged b passing through an atom as to compensate for th much greater number of such encounters.

These considerations remain valid in a general wa when the strata of equal ionisation are not exactl horizontal. If any cause, such as the influence sunlight on the ionisation, alters the height of th

[1] Abstract of a paper read on October 27 at the Cambridge Philosophical Society.

effective stratum too suddenly, the rays will be bent away upward or downward, and scattered, at the place of dislocation, and may not be able to get adjusted into the new stratum of transmission. If, however, the stratum is thick, the dislocation will be incomplete, extending over only part of it. The stratum may be expected to be of varying height, some function of the local solar time; but it is too high for any merely meteorological derangement. All rays emitted not nearly horizontally are lost: a good local earth would assist the antennas here. We can think of the constituent beam of rays connecting the transmitter with a receiver anywhere along the path: it travels most of the way, without loss except by spreading sideways, in the effective stratum, in which all such beams unite to form a nearly horizontal band of rays, the rough analogue of an optical caustic, in the almost vacuous region above. Each receiver collects from an area around it of the order of the square of the wave-length: it thus appears from numerical estimate that the amount of energy available need not be at all inadequate to account for the now familiar features of free electric transmission round the earth, even to the antipodes and beyond.

Obituary.

Dr. J. E. Campbell, F.R.S.

THE sudden death, at sixty-two years of age, of John Edward Campbell has come as a grievous shock to many. It removes from among us, in the height of his powers, a pure mathematician of strong individuality, and of conspicuous achievement in departments of research where few, in the British Isles at any rate, could bear him company. It deprives the small fraternity of mathematical lecturers in Oxford of a recognised leader, both revered and beloved. It means the loss to his College of a tutor no less devoted and successful than distinguished, who also served it in administration as acting head during the last years of its great Principal, Dr. Boyd. It leaves certain causes of philanthropic and religious work in Oxford sadly the worse off for working friends.

Campbell was the son, born at Lisburn, Co. Antrim, in 1862, of Dr. John Campbell. After going through the Belfast College of the Queen's University with distinction he came to Oxford, rather older than most undergraduates, as a scholar of Hertford. Later he became fellow and tutor of the same College, after gaining all the ordinary academical honours. He was also for a good many years lecturer of University College. He became a fellow of the Royal Society in 1905. In the years 1920–22 he was president of the London Mathematical Society; while the University of Belfast made him an honorary doctor of science.

Geometry was the strong point of Oxford mathematics in Campbell's young days, and it was natural for him to choose his line of research with a certain geometrical predilection, but he never became a devotee of the pure geometry of Chasles like others who surrounded him. Prettinesses did not much appeal to him: he wanted to plough broad acres. Looking afield for them, he began the study of the theories of continuous groups and of contact transformations which that master-geometer Sophus Lie had exploited, and with Sophus Lie he stayed long. Most of his earlier writings were contributions to Lie's theories, and presently he wrote a comprehensive book upon them, the first one by a British author, and far from a slavish reproduction of Lie's ideas. The differential geometry of surfaces has for long been another subject of his study and productiveness. More recently he has plunged into the time-space of Einstein in hopes of finding firm ground, as witness his presidential address to the London Mathematical Society.

There was a wonderful charm about Campbell's personality. Transparent rectitude, playful humour, the courage of his opinions, all shone from him to those who knew him. Affectation was as alien to his nature as idleness, and he could not be ungenial. In fact, he was the sort of Irishman whom it is a joy to run against. Some, hearing him for the first time, may have fancied that he had brought his Scotch name and his quaint accent unfamiliar to southern ears from somewhere to the east rather than the south-west of Campbeltown, and perhaps a comparatively remote Scottish ancestry may have had to do with the sturdiness of his principle and the forcefulness of his determination. Patient he was at his work, tolerant of stupidity, kindly in his joking, but there was a fire underneath which showed itself when what he thought wrong was in question. In the middle of 1914 he was a heated Ulster patriot. August came, and the lesser patriotism was submerged by a flood of the greater. A dearly loved son was an early sacrifice. During the War there was nothing else to him that mattered. He lived to serve those who fought for the right.

The War over, Campbell returned to his mathematics and to his tutorial work with young men. Of the latter, another generation or two have learned to be thankful for his precept and example. Of the former, a new book from his pen—one on differential geometry—will shortly speak.

WE much regret to record the death on October 4, at the age of seventy-seven, of Dr. Joseph Moeller, emeritus professor of pharmacognosy in the University of Vienna, and we are indebted to the *Chemiker Zeitung* for the following details of his life and work. Dr. Moeller studied in Vienna and was appointed an assistant in the pharmacological department in 1871. After the publication of his work, "Vergleichende Anatomie des Holzes," he lectured on natural products in the technical high-school at Vienna, and he was awarded the *venia legendi* for pharmacology of the University. In 1886 he was appointed professor of pharmacognosy at Innsbruck, and in 1893 he left that University for Graz. Later he returned to the Medical Faculty of Vienna, where an independent Institute of Pharmacognosy was built for him. Among other publications Dr. Moeller was the author of "Mikroskopie der Nahrungs- und Genussmittel," which has been translated into several languages; "Anatomie der Baumrinde"; and, with Ewald Geissler, of the "Real-Encyklopädie der gesamten Pharmacie."

Current Topics and Events.

IN the leading article of our issue of September 27 we dealt with the question of University Staffs and University Finance. In the course of the discussion we endeavoured to make the point that where the functions and responsibilities of the staff varied continuously from the lowest to the highest of its members, a reasonable case could be brought forward for a similar continuous variation in remuneration. To illustrate the point, the case of the University of Edinburgh was quoted, where this question has recently been raised in an acute form. We stated that the "average salary of the members of the non-professorial staff (248) was about 260*l*. and that for the professorial staff (52) about 1100*l*." Our authority for this statement was contained in a memorandum issued and signed by a staff committee of sixteen containing names of some eminence. Prof. Barger, of that University, writes querying the accuracy of these figures and suggesting that they are misleading, in that there must have been included "a large number of physicians and surgeons of the Royal Infirmary, professors in the College of the United Free Church, advocates, part-time demonstrators, etc."; that the full-time non-professorial staff is about 123 with an average salary of 433*l*. He does not tell us what would be the average salary of the professorial staff in these circumstances, nor does he quote his authority. We must leave the question to be decided at Edinburgh, but our main contention remains, of course, unaffected.

A CORRESPONDENT writes:—"Our Dutch colleagues have done well to keep green the memory of their distinguished countryman, Van 't Hoff, by openly celebrating the jubilee of the conception upon which the modern doctrine of stereoisomerism is based, published independently by Le Bel in France and Van 't Hoff in Amsterdam, in the latter part of 1874. Van 't Hoff, it may be remembered, was brought up on a strange diet of Burton's Anatomy of Melancholy, Byron, Burns, and Buckle, yet his contribution was so made and so simple that it almost forthwith gave solidity to chemists' speculations as to the character of optically active compounds in particular, and it has prevailed up to the present day. A vast amount of solid work is traceable to the influence it has had. At the public meeting, held on October 25, in the University of Amsterdam, the foreign visitors were first welcomed by a representative of the Netherlands Chemical Society; addresses were then delivered by Profs. Cohen and Walden. Prof. Cohen's speech was an eloquent appreciation of the two men, the section devoted to Le Bel being particularly happy in its allusions. Prof. Walden appears to have prepared a complete account of the development of stereochemistry up to the present day, but could only summarise his conclusions. A reception preceded the meeting, and tea followed it. Unfortunately Le Bel could not be present. The French Chemical Society was represented by M. Delépine, the English Chemical Society by Profs. Armstrong and Lowry, whilst Mr. Woolcock represented the Society of Chemical Industry and the Association of British Chemical Manufacturers. An American wandering in Europe had been captured to appear on behalf of the American Chemical Society. Prof. Walden was the delegate of the German Chemical Society and also appeared for the Russian Society; it may be mentioned that he is now professor in Rostock; he was formerly in Riga. In the evening a banquet was given at the Hotel de l'Europe. The celebration on the whole was immensely successful. A friendly party of men, all understanding one another, united to give pious effect to the feeling of gratitude which all who can appreciate the great gift our science has received from the two men in whose honour we were assembled. Such exchanges of courtesy are of great value. These meetings, however, ever serve to remind us only too forcibly of our linguistic deficiencies."

IN his presidential address to the Institution of Automobile Engineers, delivered on October 14, Dr. W. R. Ormandy reviewed the fundamental work done by Ricardo, and by Tizard and Pye, on the phenomena and principles governing the efficiency of internal-combustion engines, and then dealt mainly with problems awaiting solution. The present method of taxing motor vehicles, by cylinder capacity, has led to the use of engines having very high compression-ratios, in order to obtain a high power with a given cylinder bore; but many engines fail in efficiency owing to pre-ignition of the fuel. Hence ability to withstand high compression is a very important attribute of a motor-fuel. The work of Midgeley and Boyd in America has opened up the possibility of using low-compression fuels in high-compression engines by adding to them traces of compounds of selenium, tellurium, or lead, but such substances are difficult to handle. For engines with more than one cylinder, the problem of distribution from the carburettor to the cylinder needs investigation with the view of finding distributing systems that will enable all types of fuel to be used freely in motor engines. "Cracked" fuels are rich in unsaturated hydrocarbons, and further research is needed on the relation between chemical constitution and performance in the engine. Another desideratum is a fuel which can be exploded in very weak admixture, as a means of improving the efficiency of engines working at light loads; hydrogen and, to a much smaller degree, methyl alcohol, and ether, satisfy this condition, but are ruled out owing to inconvenience or cost. Further progress in the discovery and investigation of new alloys, particularly those containing aluminium and magnesium, will have far-reaching effects on the future of the automobile industry. For these and other researches more money is required. In Great Britain money is fairly easily obtained for new processes that have advanced to a small commercial scale, but it is very difficult to procure for a discovery that needs investigation in the laboratory; in this respect Great Britain is behind Germany, where such work was not

nterrupted even during the most stressful periods of the War.

IN his presidential address on "Bretonneau: His Life and Work," delivered at the Section of the History of Medicine of the Royal Society of Medicine on October 15, Dr. J. D. Rolleston said that Bretonneau (1778–1862), by his clinical perspicacity in conjunction with careful post-mortem examinations, did as much for the study of acute infections as Laennec did for chronic diseases. Bretonneau was a remarkable personality whose services to medicine can be summarised as follows:—(1) He established the specificity of diphtheria and typhoid fever; (2) by his doctrine of specificity he foreshadowed the germ theory of disease; (3) in opposition to the physiological school headed by Broussais, who had discarded the materia medica and reduced treatment to bleeding, leeching, and a starvation diet, Bretonneau made several contributions to therapeutics, including tracheotomy for laryngeal diphtheria, a new method of administration of quinine in malaria, the use of belladonna in constipation and enuresis, the resuscitation of purgatives in dysentery and of martial preparations in anæmia, and the introduction of cod-liver oil in the treatment of rickets; (4) his work, especially his researches on diphtheria, by which he showed that the Syriac ulcer, malignant angina and croup were the same disease, illustrated the practical value of the study of the history of medicine.

A SLIGHT earthquake was felt in Birmingham and the surrounding district on the afternoon of October 24. From the information at present received, the disturbed area is about 24 miles long, 16 or 17 miles wide, and contains about 300 square miles, the centre being a few miles to the west of Birmingham. The shock was registered at Mr. J. J. Shaw's observatory at West Bromwich at 4·49½ P.M., the maximum intensity being about four seconds, and the last tremors about four minutes later. This is the fourth undoubted earthquake that has occurred in the neighbourhood of Birmingham. About the first, on November 23, 1769, little is known. The second, on November 15, 1772, disturbed a small area about 8 miles long and 4 miles wide, including Birmingham, but lying principally to the east. Still farther to the east, and extending from Birmingham to Coventry, was the disturbed area of a slight shock on January 31, 1888. A much stronger shock on August 27, 1922, felt over an area of about 650 square miles, has been attributed to the bursting of a meteorite (NATURE, vol. 110, p. 393).

DR. P. CHALMERS MITCHELL delivered the third Benjamin Ward Richardson Memorial Lecture on "Hygiene in Animal Food: Evidence from Zoological Gardens," under the auspices of the Model Abattoir Society, on October 23. Dr. Chalmers Mitchell stated that examination of the intestines of mammals and birds shows that the more primitive types in most classes are adapted to an omnivorous diet, and that the purely carnivorous and the purely vegetarian habits are more specialised. Man, although the most highly specialised in brain, is more primitive in some other organs, including the intestines. Until human beings change their habits, a meat supply will be required. At the Zoological Gardens, meat has to be provided for carnivorous and omnivorous mammals and birds, and the animals chiefly used are horses and goats. These are killed in a modern, hygienic abattoir. The rifle is used, and although on an average three horses are required in two days, in the last twenty years in only two cases has a second shot been required. Dr. Chalmers Mitchell is of opinion that there is little or nothing to choose between the rifle and the humane killer, the poleaxe or the knife, skilfully used under proper conditions, as the instruments of actual death. In his opinion and experience, animals have no presentiment of death, and even the fresh blood and warm offal of their fellows convey no message of fear to their consciousness. But they are readily thrown into panic by being driven into unfamiliar places. Every abattoir should therefore have attached to it proper stables or byres, and the animals should be tended and finally led out by men familiar with the handling of living animals. Particulars of the work of the Model Abattoir Society can be obtained from the hon. secretary, Model Abattoir Society, at the Royal Sanitary Institute, 90 Buckingham Palace Road, S.W.

THE jubilee celebrations of the London (Royal Free Hospital) School of Medicine for Women were held last week-end. On Friday, October 24, a dinner was held at the Guildhall, which had been specially lent for this purpose by the Corporation of the City of London. Mrs. Scharlieb presided, and the toast of "Women's Work" was given by Dean Inge, Dean of St. Paul's. The toast of "The School" was proposed by Prof. E. A. Gardner, Vice-Chancellor of the University of London, and replied to by Miss Aldrich-Blake, Dean of the School; Mrs. Fawcett, Lady Barrett, and Prof. Winifred Cullis also spoke. More than 3000 women, representing all professions and callings in which women are engaged, gathered in St. Paul's Cathedral on Saturday afternoon to give thanks for "the opportunities for training, work, and service opened to women in the past fifty years." Of special interest, in view of the Jubilee Endowment Fund which is being raised to endow three chairs in memory of the three women pioneers in medicine, was the presence of the three nieces of Sophia Jex-Blake, founder of the School; and of Dr. Louisa Garrett Anderson, daughter of Mrs. Garrett Anderson, who was Dean of the School for 20 years. On Saturday, October 25, a party was held at the School, when past and present students and friends of the School were entertained. In this connexion there were some interesting scientific exhibits. Mr. Gardner, lecturer in organic chemistry, gave demonstrations with liquid air. An exhibit of crystals and crystal formation included some beautiful specimens lent by the Gas Light and Coke Co., Messrs. Burroughs and Wellcome, and the British Drug Houses, Ltd., as well as specimens made in the School laboratories. The physiology exhibits included optical illusions, tests for colour-blindness, the Sanborn apparatus for investigating respiratory exchange, measurement of

blood pressure, and microscopic specimens of various normal tissues. The Endowment Fund, headed by a donation from the Queen, has now reached a total of more than 26,000*l.*, including a reversionary gift of 10,000*l.* from a woman doctor in Harley Street.

THE Ramsay Laboratory of Chemical Engineering at University College, London, will be opened by Prince Arthur of Connaught on Wednesday, November 12, at 5 P.M. After the opening ceremony, the new building will be open for inspection.

THE Thomas Vicary lecture of the Royal College of Surgeons of England for the present year will be given at the College by Sir Arthur Keith on Wednesday, November 12, at 5 o'clock. The subject will be "Sir Richard Owen as Conservator."

APPLICATIONS are invited by the Zoological Society of London for their newly instituted Aquarium Research Fellowship, particulars of which were given in NATURE of August 30, p. 324. Applications for the fellowship must reach the Secretary of the Society, Regent's Park, N.W.8, by November 18 at latest.

APPLICATIONS are invited from members of the Royal College of Veterinary Surgeons with, if possible, experience in research work, for an assistantship in the Animal Disease Research Division of the Ministry of Agriculture of the Government of Northern Ireland. The latest date for the receipt of applications by the Secretary of the Ministry, Belfast, is November 8.

PROF. C. F. MARVIN, professor of meteorology since 1891 and chief of the United States Weather Bureau, has been appointed acting-secretary of agriculture for the United States, the secretaryship having fallen vacant through the death on October 25 of Mr. Henry Wallace, of Iowa.

THE Royal Airship Works, Cardington, require a skilled calculator, of either sex, with a university degree in science or engineering, who has taken higher mathematics in the degree examination. Experience in stressing of complicated braced structures is essential, preferably in connexion with the design of aircraft. Candidates with a knowledge of aerodynamics will be given preference. Applications should be sent to the Secretary, Royal Airship Works, Cardington, Beds.

THE Report on the Hunterian Collections of the University of Glasgow for the year 1922–23 is noteworthy for the large number of type-specimens included among the fossils presented to the geological department. These comprise plants from the Mepale Oil Shale of South Burma; Daunichthys, a new genus of fishes, with other fossils from the Dawna Hills, South Burma; corals, stromatoporoids, and brachiopods from Yunnan. Prof. J. W. Gregory also records the donation of a fine series of lead ores, calcite crystals, and other minerals from Wanlockhead and Leadhills mines by Mr. G. B. Findlay.

THE most recent annual Report of the Castle Museum, Norwich, records the gift by Mr. Gerard H. Gurney of the collection of British birds formed by his father, the late John Henry Gurney. The collection comprises 1500 bird skins and 49 glazed cases of mounted birds, and is of particular value for its examples of different stages of plumage. The report also tells of successful co-operation with the Norwich Education Committee. That body has appointed a museum demonstrator, who gives four demonstrations daily to a class of 25 senior boys or girls in their fourteenth year. The scheme allows of 500 scholars attending a full course of twelve consecutive demonstrations in natural science. A good feature is that the children have the opportunity of handling duplicate specimens.

WE have received the tenth annual Report for 1923 of the International Health Board, Rockefeller Foundation, reviewing the activities of the Board in all parts of the world. Its work includes propaganda, money grants in aid of public health education and for travelling and research fellowships, and campaigns against hookworm, malaria, yellow fever, and other diseases. The total expenditure of the Board for 1923 amounted to 2,452,728 dollars. The Report is characterised not only by the lucid and interesting text, but also by the number of excellent illustrations, charts, and maps. Short papers on the spleen index in malaria, the use of fish for malaria control, and the eradication and diagnosis of hookworm disease are included in an appendix.

WE learn from the *Lancet* that after the delivery on St. Luke's Day, October 18, of the Harveian Oration before the Royal College of Physicians of London, the president, Sir Humphry Rolleston, presented the Weber-Parkes Prize and Medal to Prof. A. Calmette, formerly of Lille, now sub-director of the Pasteur Institute, for his researches on tuberculosis. The president referred to him as the foremost authority on this subject, at the same time alluding to his researches into other aspects of bacteriology. He then presented the Moxon Gold Medal to Sir Leonard Rogers for his distinguished researches in clinical medicine. In doing so, he remarked that there were few tropical diseases in regard to which Sir Leonard Rogers had not laid the medical profession under debt by his investigations. He mentioned especially dysentery, kala-azar, cholera, and leprosy, and wished him success in his present researches into the treatment of tuberculosis.

THE New York correspondent of the *Times* states that the late Mr. Henry R. Towne, a manufacturer and engineer, has bequeathed the bulk of his estate, amounting to several million dollars, to establish museums in New York which shall be a "permanent exposition of American achievement in the peaceful arts." In case the trustees deem it inexpedient to establish such museums, the fund is to be divided equally between the Metropolitan Museum of Art and the American Museum of Natural History. A sum of 50,000 dollars (10,000*l.*) has been left for an educational campaign to bring before the American

ublic the essential facts in regard to the great industrial museums of Europe.

PLASTER casts of the Deinosaur eggs found by the Mongolian Expedition of the American Museum of Natural History (see H. F. Osborn, NATURE, October 4, p. 504) have been presented to the Trustees of the British Museum and are now on view, with elucidatory labels, in a special table-case at the entrance to the Geological Department. Beside them have been placed for comparison certain fossil eggs of reptiles, some of which have been in the Department since 1864. In this table-case it is proposed to show the more interesting recent acquisitions, changing them from time to time. There are also exhibited in it some remarkable fossil frogs and a salamander, in bituminous shale, of Oligocene (?) age, from mines at Libros, in the province of Teruel, Spain, the gift of Dom Longinos Navás, S.J., who recently described a new fauna from that locality, including also birds, beetles, spiders, and molluscs.

MESSRS. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, have just circulated another of their special scientific catalogues, namely, New Series, No. 14, which is devoted to "Zoology, Part 1—Vertebrata." Upwards of 1500 works are classified under the headings: Bibliography, Biography and History, General Systems and Iconography, Evolution, Heredity, Biology, Anthropology and Ethnology, Mammalia, Aves, Reptilia and Batrachia, Pisces, Domestic Animals and Poultry, Game Animals and Sport, Palæozoology, Miscellanea.

THE new list of announcements of Messrs. Longmans and Co. contains the titles of many books of scientific interest, among which are vol. 5 of Dr. J. W. Mellor's "A Comprehensive Treatise on Inorganic and Theoretical Chemistry"; "Glucoproteins," Prof. P. A. Levene, and "The Action and Uses of Digitalis and its Allies in Medicine," Prof. A. R. Cushny ("Monographs on Biochemistry"); and "Elements of Mechanism," Profs. F. S. Carey and J. Proudman.

MESSRS. C. Baker, of 244 High Holborn, London, W.C.1, have sent us a copy of their classified list (No. 82) of second-hand scientific apparatus. This differs slightly from the well-known quarterly lists previously issued by the firm in that the section dealing with photographic apparatus has been omitted. This is now issued separately. The catalogue still contains plenty of material, however, which is well worthy of consideration by scientific workers. Section I., dealing with microscopes and accessories, is particularly full, while there are also long lists of surveying instruments, telescopes, spectroscopes, and other physical apparatus. Surveying instruments are let out on hire for various periods by the firm.

Our Astronomical Column.

PLANET OR COMET?—A very interesting object, which was evidently stellar in aspect, but the motion of which is suggestive of a comet, was discovered by Dr. Baade at Bergedorf on October 23. The following positions have been telegraphed from the I.A.U. Bureau at Copenhagen.

	G.M.T.	R.A.	N. Decl.	Mag.
Oct. 23	$7^h\ 25{\cdot}5^m$	$21^h\ 5^m\ 16^s$	$15°\ 28'\ 0''$	10·5
25	$8\ 59{\cdot}0$	$21\ 15\ 31{\cdot}0$	$14\ 7\ 9$	9·5

Deduced daily motion, $+4^m\ 57{\cdot}8^s$, S. $39'{\cdot}15$.

If the object is a planet, it would seem to belong to the Eros type, with a perihelion far inside the orbit of Mars, so that it is of importance to obtain observations. Photography offers the readiest means of identifying it by its trail. The increase of a magnitude in brightness in two days should not be stressed, as it is difficult to estimate the magnitude of a trail.

On November 1 the estimated position is R.A. $21^h\ 50^m$, N. Decl. $9\frac{1}{2}°$, some 3° east of ϵ Pegasi. The object souths about 7 P.M., and is thus in a favourable position for observation.

TELESCOPES IN THE SOUTHERN HEMISPHERE.—An extract received from the *New Zealand Evening Post* contains an account of the inauguration of a 9-inch telescope at Kelburn, Wellington, under the auspices of the Wellington City Council. It is at present housed in a temporary wooden shed, in order to allow work on Mars to be undertaken, but a more suitable building is promised in the near future. The object glass is a photo-visual one, and it may be presumed that the mounting is equatorial, though details are not to hand. This interest of a City Council in pure science deserves grateful recognition.

From the *Observatory* for October we learn that Yale Observatory is accepting the invitation of Dr. Innes to set up a 26-inch photographic telescope in the grounds of the Union Observatory, Johannesburg, so as to continue the parallax studies of the American observatory in the Southern Hemisphere.

Dr. Innes has also organised a scheme of interchange of observers between Leyden and Johannesburg, under which Dr. Hertzsprung is at present at Johannesburg on a 15 months' visit; he will be followed by Mr. Van den Bos.

Dr. Innes makes a suggestion that every observatory should send annually to the International Astronomical Union a report on its work. Such reports would make it easier to decide on a programme of work without needless overlapping, and would help to keep observatories in touch with each other.

FINSLER'S AND ENCKE'S COMETS.—Finsler's Comet was followed at Heidelberg until October 6, but was then lost from its proximity to the sun. Dr. Kobold gives the following orbit in *Astr. Nachr.* 5326, using observations on September 20, 26, 30.

$$\left.\begin{array}{rl} T = & 1924\ \text{Sept.}\ 4{\cdot}3370\ \text{G.M.T.} \\ \omega = & 66°\ 31'{\cdot}18 \\ \Omega = & 80\ \ 2{\cdot}54 \\ i = & 120\ \ 9{\cdot}36 \end{array}\right\} 1924{\cdot}0$$

$$\log q = 9{\cdot}60855.$$

Encke's Comet was followed until October 22, being then of at least the fifth magnitude and visible in considerable twilight. The observations indicate October 31·437 G.M.T. for the time of perihelion passage.

Research Items.

A SKULL OF PAPUAN TYPE FROM COLOMBIA.—In *L'Anthropologie*, T. xxxiv., No. 5, Dr. R. Verneau directs attention to a close resemblance between the skull of a Tunebo Indian and Papuan skulls, particularly skulls from the island of Mallicolo (New Hebrides). Not only is the general morphological resemblance remarkable, but the absolute measurements are extremely close. The cranial index in each case is 69, and both are hypsicephalic. The maximum transverse diameters vary by three millimetres only, the vertical diameters by one millimetre, and the maximum antero-posterior diameters are identical. In both cases the frontal region is narrow. The chief difference is that the Tunebo skull has a higher cranial capacity, 1775 c.c. as against 1550 c.c. in the Mallicolo crania, probably an individual variation. Where in other respects it varies from the Mallicolo characters, it approaches those of other Papuan crania. Notwithstanding the danger which attaches to conclusions drawn from a single specimen, it appears reasonable to conclude that the Tunebo skull belongs to the Papuan type. Ten Kate and Rivet have demonstrated that traces of the early type of S. American man represented by the Lagoa Santa skulls are to be found from Southern California to Patagonia, while de Quatrefages and, later, Rivet pointed out the close resemblance of this type to the hypsistenocephalic type of Melanesia and Australia. The importance of the Tunebo skull is that it is the first of the type to be found in the Eastern Andes and supplies a link hitherto missing between examples of the type on the Atlantic and Pacific sides of the continent.

SURVEYS IN BHUTAN AND SOUTHERN TIBET.—In the *Geographical Journal* for October, Maj. F. M. Bailey describes a journey which he took for political reasons into Bhutan in 1921 and a subsequent journey through hitherto unexplored parts of that country and Tibet. His route was from Chumbi (Yatung) across the foothills of the Himalayas by Paro to Bumtang, where unexplored ground began. From Bumtang he passed northward into Tibet by the Mönlakarchung Pass to the lake known as Yamdrok Tso and thence westward by Talung to Gyantse. Capt. H. R. C. Meade with a survey party accompanied Maj. Bailey, and a map of their surveys is published with the paper. An area of 9493 square miles, including 6589 original survey and 2904 revision, was mapped on a quarter-inch scale, the work being based generally on triangulation carried out during the journey. Of this area, more than half consists of accurate plane tabling and photo-survey, and the rest of reconnaissance work. The whole of the Mo Chu basin in North Bhutan is still unsurveyed, though several prominent snow peaks were fixed, and the map between Bumtang, where touch was lost with the Assam triangulation, and Lhunbushö (on the Yamdrok Tso) is more or less in the air, and adjusted by astronomical work. The work in the *Geographical Journal* is on a scale of 1 to 750,000.

GONAD AND SOMA IN THE FOWL.—Pézard, Sand, and Caridroit (*C.R. Soc. Biol.* v. 89, 1923) describe on p. 1271 a case of feminisation of an adult Brown Leghorn cock which was castrated at the age of 3 months, and a year later received two implants of ovaries from hens of the same breed. The head furnishings and plumage are now henny. On p. 1103 the authors describe how in plucked ovariotomised hens, as the ovary regenerates, the growing feathers of the lumbar region mirror exactly the various phases of the process. In vol. 90, p. 623, they discuss the results of ovaria implantation into a castrated Brown Leghorn × Silv Dorking F_1 male, and of implantation of ovaria tissue without castration. In both instances there a swing to the plumage of the female and the appea ance of new pigmentation which differs according whether Leghorn or Dorking ovary was implante They suggest that there is a racial specificity of ovaria secretion apparently ignoring sex-linked inheritanc On p. 676 they discuss the phenomenon of pœcilandry the existence of two sorts of males in one and the sam breed. Cocky-feathered Sebright Bantam cocks ar to be found in France. From experiments in whic the testes from henny-feathered Sebright cocks wer implanted in a cock of a cocky-feathered strain, the conclude that the testes of the henny-feathered coc exercise the same effect as an ovarian implant. O p. 737 they describe briefly certain experiments o gonadectomy and implantation, and conclude tha castration results in a neuter form, which they designat " the species type," since they consider it to represen the common heritage of both sexes of the same breed the base upon which the end-result is built.

THE FOOD OF THE WILLOW-GROUSE IN NORWAY.—To *Bergens Museums Aarbok* for 1922–23, Dr. Jens Holmbœ contributes a detailed study of the food o *Lagopus lagopus* in the various parts of Norway i every month of the year, based on material collecte during 1921–23. So long ago as 1753, Pontoppidan remarked on the difference between the summer and winter diet, the latter consisting mainly of birch-twigs. It has also been recognised that the young eat insects, but these are soon given up and the birds live mainly on seeds, berries, and leaves. Dr. Holmbœ's researches show that there is also a considerable difference of food in the different regions, especially as between the coast and the inland districts, and this is chiefly manifest in winter. The reason clearly is that the snow renders the upland vegetation more or less inaccessible, so that the birds are driven to eat the twigs and buds of birch and other trees, or else to migrate to more favourable districts, whereas along the coast the snow does not lie so long and is swept away from the moors. Birch-twigs can be regarded as at best a substitute food, whereby the grouse can stay the pangs of hunger and live through the winter, but it would scarcely be satisfying in the long run. The Norwegian willow-grouse has until now been free from the parasite *Trichostrongylus pergracilis*, which is so dangerous to British grouse. This may be because the Norwegian birds do not eat much ling (*Calluna vulgaris*), which, as Leiper has shown, harbours this parasite. It now appears, however, that in the coast districts of Norway, Calluna does often serve as food for the grouse, so that increased effort should be made to prevent the introduction of British birds.

A SPECIES OF MONILIA ASSOCIATED WITH SEVERE ANÆMIA.—European residents in the tropics frequently suffer from a chronic or intermittent intestinal disturbance, in which amœbæ or dysentery bacilli are not found, to which the sufferers give the name " sprue." If this is a true infectious disease, an active agent is still to be sought, and therefore considerable significance attached to the work of Ashford in Porto Rico, in which it was suggested that the micro-organism *Monilia psilosis* was responsible for the symptoms. Lawrence Weld Smith, of the Department of Pathology and Bacteriology, University of the Philippines, now publishes in the *Philippine Journal of Science* (April 1924, vol. 24)

otes upon eight cases of severe anæmia associated ith the sprue syndrome in which *Monilia psilosis* shford has been isolated.

A BIOCHEMICAL BASIS TO DISEASE RESISTANCE.—n Œnothera, resistance to mildew disease is in-erited as a unit factor. Marañon has therefore used his species mainly in an investigation, described in he *Philippine Journal of Science* for April 1924 vol. 24, pp. 369-441), in which a preliminary com-arison is made of the biochemical constitution of isease resistant and susceptible strains. The con-lusion is reached that the resistant strains are haracterised by higher tannin content and more ater-soluble acid, whilst immune forms are com-aratively high in total nitrogen and total ash, the itrogen increase being mainly in amino-acids and itrogenous compounds of non-basic character, the sh increase in calcium and sulphur. Examination f disease resistant and susceptible strains of *Syringa ulgaris*, *Desmodium canadensis*, and *Solidago cana-ensis* is said to give concordant results.

AN EXPLOSIVE FRUIT.—The beautiful purple lowers of the South European species of toothwort, *athræa clandestina*, must have been noticed by nany visitors to the London parks; parasitic on lm or other trees and flowering freely in May, it is o be seen in Regent's Park, in the Bedford College rounds, at Kew, and at the Royal Botanic Society's arden. In the Quarterly Summary of the last body for October 1924) the Curator, Mr. J. L. North, has n interesting note upon the seed dispersal of the lant, which fruited freely in the Royal Botanic ociety's garden this summer. He was surprised to otice the force with which the seeds were scattered y the explosion of the capsule when squeezed etween finger and thumb. Although the capsule s born at ground level, the seeds are shot out so iolently that when, with the assistance of Prof. ates, their flight was followed and distances measured, ome of the seeds were found to have travelled 27 feet. his may throw some light upon the dispersal of the lant in the garden; originally planted upon the oot of a beech tree, it has now spread to the roots f other plants to a distance of 40 yards on either ide.

A NEW VIEW OF SOIL FERTILITY.—Prof. W. F. ericke of the University of California certainly eems to have developed a refreshingly novel point f view in relation to the problem of soil fertility, o judge from a preliminary note published in *Science* or April 4, which has just been brought to our notice. ointing out that the rapid growth of a crop often roduces a temporary depletion of some essential oil constituent, he investigated by the water culture nethod the effect upon the growth of a plant of a eriod in which the salt supply provided lacked one ssential element. The striking result was obtained hat after plants had grown for one month in complete utrient solution, a great enhancement of growth, ncrease in weight, and advance in date of maturity esulted from the transfer to solutions *devoid of otassium*. In the light of these experiments Prof. ericke attempts a reinterpretation of the results btained by Stewart (Journ. Agr. Res. 12, 311-368, 1918), in which it was shown the barley crop very apidly depleted the soil of nitrogen in the cases here large crops were obtained. From other water ulture experiments Gericke had reached the con-lusion that the presence of the nitrate ion materially affected the availability of the potassium ion to the plant, and he therefore inclines to associate these large yields in soils early depleted of nitrate with these new experiments in which lack of available potassium after the first few weeks of growth favours increased growth and yield. Needless to say, potassium, and indeed the full supply of nutrients, proves to be essential during the first few weeks of the plant's growth. Prof. Gericke reports similar improved development and yield in plants transferred, after four weeks in full mineral solution, to media devoid of phosphorus (*Science*, September 26).

THE PATHS OF CYCLONES.—The *Monthly Weather Review* for June contains an article by J. W. Sandström on "Investigations relative to the Polar Front," translated from *Meteorologische Zeitschrift* for February by Mr. W. W. Reed. It deals chiefly with "cyclonic families," and an attempt to apply the theory to practical weather service work. The theory asserts that after the passage of a cyclone, each succeeding depression has its path somewhat to the south of that of the preceding one until the cyclones move tangentially to the tropical belt of high pressure. The first members of the family appear in high latitudes. The theory is a consequence of the polar front conception put forward by Prof. J. Bjerknes. When the path runs in the vicinity of the tropical "high," a new cyclone family, it is said, appears in the north and behaves in the same way as the disturbances of the earlier family. The author, on the basis of this law, sought to draw in advance the paths of coming storms; he soon found that the storms followed quite different paths. An investigation was made on the basis of Hoffmeyer's charts. The first test failed to show that the succeeding cyclone lies more often to the south than to the north. The tracks of disturbances from Hoffmeyer's charts showed that the paths often intersect the paths of earlier disturbances in all kinds of ways. The author is of opinion "(1) that cyclone families in the Bjerknes sense do not exist, (2) that the behaviour of cyclones is not regulated by a polar front, and (3) that the discontinuity, which is called the polar front, appears, in general, only with the cyclones and is a result of their activity."

HISTORY OF OPTICAL GLASS.—In any historical appraisement of the makers of optical glass one name alone stands proud of all others—that of Pierre Louis Guinand. Endowed neither with riches nor education of a conventional kind, he converted a haphazard process of selection, which failed to satisfy the cravings of opticians, into a definite industrial art, the essentials of which constitute the universal practice of the present day. At the request of the German optician Utzschneider, Guinand in 1805 left his home in Switzerland to establish at Benediktbeuren an optical glass works, upon the success of which the fame of Utzschneider's firm and its productions quickly extended. According to the investigations of Dr. M. v. Rohr, published in the issue of *Die Naturwissenschaften*, September 26, it would appear that Joseph Fraunhofer, a young artisan in the glass-grinding shop, who had already won the good opinion of his employer, was transferred to the glass works in order that he might master the methods of Guinand. Two years thereafter he was placed in complete control—Guinand, the old experienced and renowned man of sixty-three, was made subordinate to the ambitious youth of twenty-five. Guinand returned to his old home in Le Brenets, and after the termination of his agreement with Utzschneider recommenced the labour of his life. His process was established by the Guinands and their associate, Bontemps, in France and Britain, where the manufacture has flourished and endured. In Germany the industry ultimately declined and entirely disappeared. Thus the ascendancy passed

from Germany until, in 1884, works were established by Abbe and Schott in Jena, where the process of Guinand is once more practised.

THE PHOTOELECTRIC EFFECT WITH MINUTE MERCURY SPHERES.—Dr. E. Wasser, in the *Zeitschrift für Physik*, September 12, describes an investigation of the photoelectric effect, using submicroscopic mercury spheres produced by evaporation and subsequent condensation in dry nitrogen and carbon dioxide. The particles were observed in an electric field with an Ehrenhaft condenser, the field being so adjusted that the observed particle remained suspended in the gas. Light of wave length $\lambda = 275\mu$ was employed to produce the photoelectric effect, and it was found that, up to about $1{\cdot}2 \times 10^{-5}$ cm. radius, the spheres were negatively charged, or there was an inverse photoelectric effect. From this radius up to $1{\cdot}9 \times 10^{-5}$ cm. some particles are charged positively and some negatively, while above $1{\cdot}9 \times 10^{-5}$ cm. radius all are charged positively. The magnitudes of the charges which the spheres acquire seem to depend on the radius; with small spheres charges of $0{\cdot}6 \times 10^{-10}$ electrostatic units, or about one-eighth of an elementary quantum, are much more frequent than charges equal to that of an electron; above 3×10^{-5} cm. radius, charge alterations down to about half the charge of an electron were observed. It is shown that these effects are not due to ionisation of the gases. The question whether the photo-effect has its origin in the adsorbed gas on the surface of the mercury, or in the interior of the metal, can only be answered when it is possible to investigate the same test particle with different gas pressures.

ELECTRIFICATION DUE TO BUBBLING GASES THROUGH FLUID METALS.—Messrs. A. Coehn and E. Duhme describe a series of experiments in which hydrogen, nitrogen, carbon dioxide, oxygen, and ammonia are bubbled through pure mercury and dilute amalgams (*Zeitschrift für Physik*, September 17). All these gases behave alike, and leave pure mercury negatively charged, while weak amalgams of "non-noble" metals (sodium, zinc, cadmium) are positively charged; "noble" metals (tin, copper, silver, gold) do not produce this reversal of sign. Lenard has concluded that, in the case of non-metallic fluids, the function of the bubbling gas is to break up the electrical double layer at the surface, and to carry off the charge which is least firmly held by the fluid. It appears that with pure mercury the electrons are held by the metal which remains behind more firmly than the positively charged mercury particles, which are carried off by the gas as a fine dust, giving it a positive charge. The effect with amalgams depends on the position of the metal employed in the electric tension series; a sodium atom, for example, gives up an electron to the mercury; and it must be assumed that the Na^+ ions bind Hg atoms, forming large $Na^+(Hg)_n$ complexes, which are less easily carried away by the gas bubbles than the corresponding negatively charged mercury particles. Thus the fine dust carried away by the gas must consist mainly of pure mercury; this is not necessarily the case with amalgams of the "noble" metals.

THE DOPPLER EFFECT AND CANAL RAYS.—When the light from canal rays is observed spectroscopically, the spectral lines are seen to be widened, owing to the different velocities of the radiating atoms. Dr. H. Krefft has photographed the β line of hydrogen under different conditions, and has measured photometrically the blackening throughout the band (*Annalen der Physik*, Aug.). He finds that the Doppler band is separated from the line which comes from atoms having small velocities; and that the intensity curve of the band has in general two maxima. The velocities corresponding to these are related, when the discharge voltage is abo 40,000, not as $\sqrt{2}$: 1, as is the case with the spark lin of oxygen and nitrogen; the ratio being larger th 2 : 1, and increasing with the voltage. Previo observers have found a limit for the Doppler effe when the voltage is raised sufficiently; but Kref who has used voltages from 1400 to 70,000, finds f the higher voltages that the effect increases regularl proportionally to the square root of the dischar voltage. The difference between the velocity distr bution, as determined by the Doppler effect, and t curve for that of the positive H atoms, as determine by electromagnetic analysis, is shown to be a necessar consequence of the facts that the carriers of t Balmer lines have no charge, and that the ratio of th numbers of positive and of neutral atoms depen on the velocity. With the spark lines of oxygen an nitrogen, where the "carriers" are the positive atom the two curves are nearly the same; and the tw maxima of blackening indicate a velocity ratio $\sqrt{2}$: 1, which is consistent with the assumption tha the lower velocity is produced by the movement of molecule with positive charge through the same voltag drop that produces the higher velocity in the positivel charged atom. The oxygen spark line $\lambda = 4591$ indicates extra high velocities, which must be due t the fall of doubly charged oxygen atoms through th discharge space.

MOBILE COMPONENTS OF CRYSTALS.—In Band 18 Heft, 1 of Eucken's *Fortschritte der Chemie, Physik un physikalische Chemie*, 1924, Dr. Hüttig contributes a essay with the somewhat curious title: "Übe Gitterbestandteile die im Kristallgitter vagabun dieren." It is pointed out that in some cases th particles in a crystal lattice, besides oscillating abou positions of equilibrium, may move through th lattice, and the rapidity with which this motion take place will influence the pressure-composition curve when a volatile constituent is withdrawn from system. A selection of such curves based on ver recent experiments is given, and these are divided int three groups. In the first group, *e.g.*, H_2O/LiCl, th solid residue consists of a mechanical mixture of definit compounds, and the phase rule applies in the simples form. When a single compound is present, th pressure curve drops vertically towards the composi tion axis. In the second group, *e.g.*, H_2O/WO_3 H_2O/Sb_2O_5, H_2O/SiO_2, the behaviour is intermediat between those of the first and third groups. In th third group, *e.g.*, O_2/UO_2, H_2/Li, and H_2O/Al_2O_3, th curve sinks continuously without any steps or change of direction. The laws of solution can be applied t the examples in the third group, and the whole curv covered by an equation $\log(p_0/p) = k/n$, where p, p_0 are the vapour pressures of the solution and of the pur volatile constituent, respectively, n the simple molecular weight of the volatile constituent, and k a constant. It is mentioned incidentally that X-ray experiments have shown that some so-called "colloidal hydrates" contain definite compounds. Thus, white tungstic acid does not show the spectrum of WO_3, and is presumably not a mere colloidal association of H_2O and WO_3.

ERRATUM.—We regret that in our reference to Early Christian legends in India (NATURE, October 4, p. 515) by a slip Malabar was substituted for Mylapore in the last sentence. Mr. Frederick Fawcett, who writes to point out the error, states that while the legend of St. Thomas is very much alive at Mylapore and on the west coast, it does not occur in the Malabar district of British India. He adds that the legends of St. Thomas on both the west and the east coast agree in a remarkable manner

Lake Level in Relation to Rainfall and Sunspots.

By Dr. F. DIXEY, Government Geologist, Nyasaland Protectorate.

VARIATIONS IN THE LEVEL OF LAKE NYASA.

THE present investigation was commenced towards the end of 1923 as a result of inquiries made as to recent variations in the level of Lake Nyasa; the information was required in connexion with proposed constructional work at or near the southern end of the lake. At the time the only information readily available was a record at the Marine Transport Department of the rise and fall of the lake level at the Bar, Fort Johnston, since 1916; the additional data now presented have been collected from many sources, and especial thanks are due to several past and present officers of the Marine Transport Department, as well as to residents and missionaries stationed on the lake.

The results of the investigation indicate that the lake level varies in close sympathy with the sunspot numbers. This relation is apparently due to the dependence of the lake level upon evaporation as well as upon rainfall, and to the fact that evaporation is very largely controlled by solar conditions. The researches of W. Köppen and others have established beyond doubt that there is a close connexion between sunspots and tropical temperature, the latter being 1·1° F. higher at sunspot minima than at sunspot maxima. It is reasonable to conclude that evaporation proceeds at a greater rate during the periods of higher temperature; hence at sunspot minima evaporation will be increased and the level of a lake suitably situated will consequently fall, whereas at sunspot maxima evaporation will be decreased and the level of the lake will rise. In the case of Lake Victoria, for example, this relationship has been found to be so intimate that it yields correlation coefficients of between 0·8 and 0·9; recent work has shown, however, that, for this lake at least, rainfall is also an important factor. The variations observed in the levels of Lakes Victoria and Albert and in that of Lake George in New South Wales, and shown to be closely associated with the seven-year periodicity of sunspot phenomena, have now been found to occur in the case of Lake Nyasa also.

Lake Nyasa, the third largest lake in Africa, is the southernmost of the Rift Valley lakes; it is 10,200 square miles in area and 360 miles in length, and it lies at an altitude of about 1645 feet. It is exceptionally deep, so that in places its floor extends down to about 600 feet below sea level. The area of the territory drained by the affluents of the lake is about three times that of the lake itself. The evidence of raised beaches shows that the level of the lake has fallen several hundred feet within late geological times. Until within the last few years the lake was drained by the Upper Shire river, which has now, however, become more or less completely silted up.

The curve depicting the variations in the level of Lake Nyasa is shown in the accompanying diagram (Fig. 1), together with those for Lakes Victoria and Albert and also those representing the rainfall of Uganda and the monthly sunspot numbers. It will be seen that Curve 3, showing the rainfall variation in Uganda according to figures available at the time, indicates that the level of Lake Victoria is undoubtedly dependent upon the rainfall, although the connexion is apparently small. Later work, however, has shown that the relation existing between the lake level and the rainfall of the whole of the surrounding area is much closer than would be supposed from this curve.

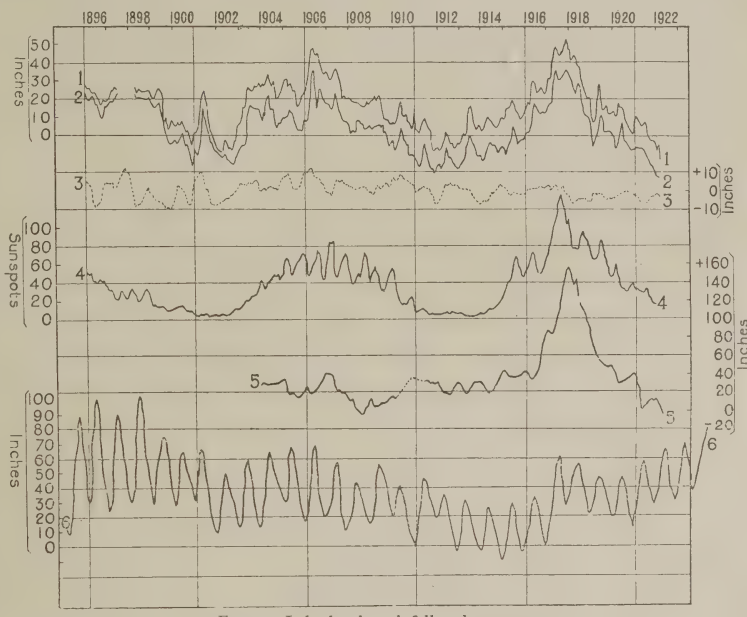

FIG. 1.—Lake levels, rainfall and sunspots.

Curve 1. Maxima, Lake Victoria.
Curve 2. Minima, Lake Victoria.
Curve 3. Rainfall in Uganda. Deviations from normal summed up in overlapping periods of six periods.
Curve 4. Monthly sunspot numbers.
Curve 5. Lake Albert.
Curve 6. Lake Nyasa: zero on the curve corresponds to 90 ft. mark on Lake George at the Bar, Fort Johnston.

Curves 1-5 are from Geophysical Memoir No. 20 (Meteorological Office, 1923). "Variations in the Levels of Central African Lakes Victoria and Albert," by C. E. P. Brooks.

Mr. P. Phillips, Director of the Meteorological Service, Cairo, has recently pointed out that there is actually a very high correlation (0·915) between the rainfall of the "Lake Plateau," which includes parts of Kenya Colony and Tanganyika Territory as well as Uganda, and the change in the level of the lake from year to year.

It is of interest to note that for the period under review the annual variations in the level of Lake Nyasa appear to have decreased, so that while they exceeded six feet in amount between 1895 and 1899, they have only attained about three feet since 1915; nevertheless, observations made at Cape Maclear for the few years succeeding 1875 show that at that time the variations were again only about three feet. These variations are all much greater than the corresponding changes in the levels of Lakes Victoria and Albert, and they are large also even as compared with the greater variations associated with the sunspot effect.

The curve of the Lake Nyasa levels has been compiled from observations made at different periods and at different stations as follows:

1895–1914, Nkata Bay; 1914–1916, Monkey Bay;

1916–1924, The Bar, Fort Johnston. Fortunately, the Monkey Bay records overlap those of the other two stations. The first part of the curve, due to Captain E. L. Rhoades, is based upon observations representing for the most part only the approximate maximum and minimum readings for the year, whereas the last part is plotted from readings taken upon the sixth day of each month; nevertheless the relation of the lake levels to sunspot maxima and minima is clearly indicated. In view, however, of the imperfection of the data available, and also of the greater ratio of the annual variation to the "sunspot variation" as compared with Lakes Victoria and Albert, the correspondence between lake level and sunspot numbers is perhaps less satisfactorily indicated than in the case of these two more northerly lakes.

The following relationships as to lake levels and sunspots are evident from a comparison of the curves given in Fig. 1. The level of Lake Nyasa stood at a minimum during the sunspot minima of 1902 and 1913, and at or near a maximum during the sunspot maxima of 1895, 1906, and 1917; similar variations occur in the level of Lake Victoria and also in that of Lake Albert so far as the available records go. Owing to the slightly longer range of the Lake Nyasa records, the sharp rise preceding the maximum of 1895 is more clearly indicated for this lake than for Lake Victoria. Minor maxima in the lake levels occur in 1898, 1900, and 1910–11, two of them at least being clearly related to corresponding minor maxima in sunspot numbers.

An important difference exists between the Lake Nyasa curve for the period 1920–23 and the curves of the other lakes for the same period; while the fall following the maximum for 1917 ceased in the case of the former in 1920, it continued in the case of the latter for at least another two years. Moreover, early in 1924 the level of Lake Nyasa was higher than it had been at any time since 1898, and it appears probable that the maximum of 1898 will be reached or even exceeded in the near future. The explanation for these variations may perhaps be connected with exceptionally low level attained by Lake Nyasa about the end of 1914, during the last minimum, when it was lower than it had been for at least twenty years. The accompanying period of depression so much affected the Upper Shire river, which normally formed the outlet of the lake, that it became too feeble to remove not only the silt usually carried by it but also the detritus carried in by its tributaries; consequently, its bed became more and more silted up until coarse reeds and other forms of vegetation were firmly established upon it. Although the mean annual level of the lake stood more than four feet higher in 1923 than in 1914, and was still rising, the Upper Shire river remained impassable. Moreover, when the river begins to flow again with the first rains of the year, its direction of flow is now reversed, so that from a point about forty miles south of Fort Johnston the water actually flows towards instead of away from the lake. Since the gradient of this part of the valley of the Upper Shire has been given as about six inches per mile, this reversed flow indicates the rising of the river bed through a considerable height. The accumulation of sediment and of vegetation along the course of the river thus acts as a barrier impeding the discharge of water from the lake, and to this barrier may be ascribed the otherwise inexplicable rise of 1920–23 and afterwards. Further reference to the history of the Upper Shire river will be made in a later paragraph.

The conclusion already drawn from the Lake Nyasa curve that the lake level varies in sympathy with the sunspot numbers receives support from the general statements of early pioneers prior to the commencement of the actual measured record in 1895. The available data may be summarised as follows:

Date.	Lake Level.	Sunspots.
1830	Very low.	
1857–63	Very high.	Maximum about 186
1873	High.	Maximum about 187
1875–8	Falling; annual variation about three feet.	
1882	High.	Maximum 1883–4.
1890	Very low.	Minimum 1890.
1892–5	Rising rapidly.	Maximum 1895.

Marks on the rocks at Monkey Bay and elsewhe indicate that at some early period of unknown d the level stood six feet nine inches higher than 1897, which otherwise constitutes the highest recor level. According to native information, this old hi level period occurred not less than one hundred ye ago.

The diurnal variations of level to the extent about four inches, similar to those recorded from La Victoria, occur also on Lake Nyasa, and they m probably be ascribed to the same cause, namely, t influence of the land and lake breezes.

Recording piles have now been established at K Kota and Nkata Bay as well as at Fort Johnston, that there should be available for the future a m detailed and more complete record of the variatio of lake level than has been possible in the past.

The Upper Shire River.

Reference has already been made to the chan that have taken place in the Upper Shire river duri recent years. In the early history of the Protector the river formed an invaluable highway from t lake down to Matops, a distance of about ninety mile below Matops almost as far as Chikwawa the ri was rendered impassable by the Murchison Catarac Navigation for the larger lake steamers, drawi up to 6 feet of water, persisted at least until abo 1900, apart from occasional periods of low wat during which it was restricted to the upper reach of the river. From 1905 onwards, owing to a stea fall in the mean annual level of the lake, navigati on the river became more and more difficult, and t lower limit of navigation receded slowly up-strean about 1910 the river became too shallow even for sm craft, and from then until the present day the Upp Shire has been entirely useless as a waterway. the river fell and the accumulating silt enabled veg tation to become established and this in turn induc a more rapid deposition of sediment, large portio of the river-bed become swampy and ultimately dr Of late years, as has already been stated, when t river begins to flow with the first heavy rains of t year, it actually carries water for about forty miles in the lake instead of away from it. The accumulatio in the river bed have proved so firmly established ar so difficult of removal that the steady rise of the lal of the last few years has failed to give the riv sufficient power to clear them away; this is the mo remarkable when it is considered that not only h the level of 1905 been exceeded, but also that of 189 when the river traffic was at its height, is bei rapidly approached.

The remarks made as to the silting up of the Upp Shire apply also to the old Lake Malombe, throug which the river passed. The lake is now little bett than a large swamp, which is diminishing in are from year to year.

While an essential cause of the present silted-up condition of the Upper Shire was thus in all probability the steady fall of the level of Lake Nyasa from 1905 to 1914, other factors have probably acted as contributory causes. For example, during the last 60 years or more the Upper Shire valley, in common with other parts of the Protectorate, has been very largely deprived of its natural covering of vegetation; this has of course led to the rapid erosion of soil and even of sub-soil, particularly on the steep hillsides that form the valley walls. The streams flowing swiftly down from the hillsides have carried with them this eroded soil; on reaching the broad flat floor of the Upper Shire Valley, they have been forced to deposit their load in the main river and its larger tributaries. In this way the Upper Shire might well have received more detritus than it could dispose of, even apart from the added difficulty of diminished outflow from the lake. While it is true that the run-off from the hillsides has probably increased in speed and in amount, and should thus have helped to clear the debris, the combination in the main valley of a wide flat floor and steep walls has more probably overcome this factor and led to increased aggregation.

To whatever factor the blocking of the Upper Shire may be due, it is clear that it must bring about a rising of the level of the lake, although from the few figures at present available it appears unlikely that a rise of more than one foot per year at the most would result from this cause alone. In view of the larger variations of lake level due to other causes, however, it is practically certain that earlier or later an unusually high level of the lake would give the Upper Shire river a temporary advantage over the obstructions in its course. Once this advantage were gained the river would in all probability be able for a time to keep its course clear and thus assist in lowering the level of the lake; this process would gradually place the river in danger of becoming silted up again, when the cycle already outlined would begin afresh. It is of interest to note in this connexion that according to native tradition, as I am informed, the upper part of the Upper Shire valley is subject to periodical flooding on a large scale.

One other complication in tracing the history of the Upper Shire river is the possibility of the level of the land along the course of the river, or in the lake basin, having been slowly raised or lowered even within historical times. Certainly, within very late geological time, as proved by the existence of raised beaches, the lake stood several hundred feet above its present level; from the information at present available, however, it would be difficult to say whether the barriers that held the lake up to this great height have been removed by a tilting of the land or by some process of erosion similar to that described in the preceding paragraph. Attempts are now being made to determine how far available historical records indicate the existence of any such tilting. Certain it is that the strip of country along the line of the lake and the Upper Shire valley is in an unstable condition as compared with the country bordering it; this is evident from its late geological history and the frequent occurrence of earthquakes there even to this day.

Summary and Conclusions.

An examination of available records of the rise and fall of Lake Nyasa indicates that the level of this lake, in common with the levels of Lake Victoria and Lake Albert, varies in close sympathy with the number of sunspots; moreover, certain minor variations associated with sunspot phenomena are also common to all three lakes so far back as the records for each can be traced. While the rainfall records of the Lake Nyasa area are not sufficiently complete to be of value in this connexion, it has recently been shown that, in the case of Lake Victoria at least, a very high correlation exists between lake level and the rainfall of the surrounding plateau; thus the rainfall of the plateau is also closely related to the number of sunspots. Accordingly, in view of the sympathetic variation in the levels of Lake Nyasa and Lake Victoria, and the relation of the level of the latter lake both to sunspot maxima and to rainfall, it is more than possible that the level of Lake Nyasa and the rainfall of its catchment area as a whole may both attain to maximum values in parallel with the eleven-year periodicity of sunspot phenomena. It is of great interest in this connexion to observe that the great drought of 1921–22 affecting this part of Africa occurred in a period of sunspot minimum, that during this time the levels of Lake Victoria and Lake Albert were both falling at a considerable rate, and that the drought of 1911–12 also occurred in a period of sunspot and lake level minimum. Again, the Lake Nyasa maxima of 1896–8 and 1917 were immediately preceded by periods of exceptionally heavy rainfall. Finally, it has been observed by the older residents of Nyasaland that famines similar to those of 1912 and 1922 have occurred at intervals of ten or eleven years over a considerable period in the history of the country; thus it is not unreasonable to assume that famines will recur in the future at similar intervals, unless due precautions are taken to avert them.

As regards the level of Lake Nyasa, however, it appears that the condition of the Upper Shire river and its capacity for carrying off excess waters from the lake must act as an additional but irregular factor. The very low level attained by the lake in 1914, combined with certain other factors, led to such an extensive silting-up of the bed of the river that the succeeding maximum failed to give the river sufficient power to scour out its course. Consequently on passing the maximum the lake level fell but slowly; furthermore, it began to rise again, and rise rapidly, about three years before the anticipated minimum. By the early months of 1924 this rise had brought the level almost up to the high maximum of 1896–8 when river traffic was at its best, but even so the river remained practically dry and totally unfit for navigation. Hence during the next few years the lake may be expected to rise again at least to the highest level on record; if this rise enables the Upper Shire to remove the obstruction from its bed, the river may begin to assist again in bringing about a lowering of the lake level, and incidentally to become fit for navigation once more. The unexpectedly early and rapid rise of the lake that commenced in 1920, and even persisted through the drought of 1921–22, may thus be ascribed very largely to the virtual damming-up of the lake outlet by the prolonged accumulation of sediment and vegetation in the bed of the Upper Shire.

While fluctuations of considerable magnitude have occurred in the level of the lake during historic time, there is no evidence to show that any progressive rise or fall has taken place. This is in accord with the findings of a Commission recently appointed in South Africa to inquire into the cause of the disastrous droughts of recent years; it was found that there was no evidence for any progressive increase or decrease in the rainfall of the Union during historic time, and that the desiccation observable in many parts of the country was due, not to diminished rainfall, but to failure of the land to absorb the rain as it fell. The failure was regarded as due largely to the destruction of natural vegetation, to the consequent erosion of soil, and to the hardening of the surface of the land by sun-baking and the trampling of cattle.

A New Loop Galvanometer.

A NEW loop galvanometer made by the firm of Messrs. Carl Zeiss, of Jena, possesses several novel features. Although with its most insensitive arrangement it is capable of detecting a microampere, it is not easily damaged mechanically, and with a suitable field stand (Fig. 1) it can be used for taking out-

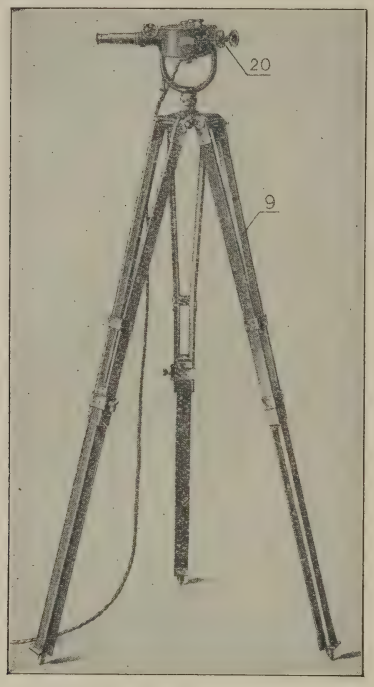

FIG. 1.—Galvanometer on field stand for outdoor observations.

door observations. In principle the instrument utilises the action of a magnetic field acting on a current carried by a light loop of metal foil. The magnetic field is produced by two strong permanent magnets the unlike poles of which face one another (Fig. 2).

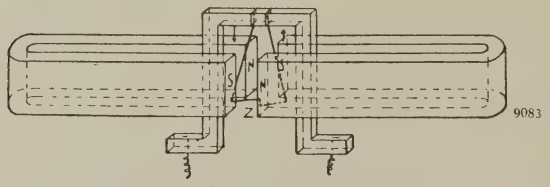

FIG. 2.—Diagram showing the arrangement of the magnets and the loop in its hanging position of stable equilibrium.

The sensitivity is therefore twice as great as when one magnet only is used. The internal resistance of the galvanometer is only about eight ohms.

The general appearance of the galvanometer is shown in Fig. 3. The deflexions of the loop are viewed through a microscope, having in its field of view a scale divided into 100 parts. For ordin purposes, daylight can be used to illuminate the lo When, however, greater sensitivity is required a supplementary microscope and a small electric la are employed.

The entire galvanometer casing is mounted trunnions, and by turning the whole instrum round, the loop can be used either in its sta position, where the sensitivity is least, or in unstable position, pointing vertically upwards, wh its sensitivity is about six times greater. The great sensitivity is about the hundredth part of a mic ampere. The loop is enclosed in a small glass box, a is thus protected from currents of air. When t current exceeds about the thousandth of an ampe the loop may cling fast to the glass sides. In t case tapping with the hand usually sets it free.

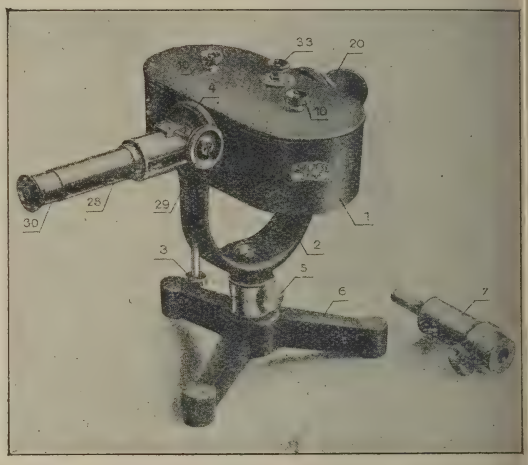

FIG. 3.—Loop galvanometer with microscope magnifying 80 times, f general laboratory and outdoor use. Sensitive to about 3×10^{-7} 6×10^{-8} amp.

small spring hammer, however, is provided outsid the box when more vigorous tappings are required When the loop is twisted up by an excessive curren it can be untwisted by a polished non-magnetic needl

All the optical arrangements for this instrumen are most interesting. The phenomena of interferenc bands are utilised; but this necessitates keeping th free surfaces of the optical parts very clean.

To the same degree of accuracy as with a mirro galvanometer, the deflexions are proportional to th strength of the current and they are aperiodic. A the internal resistance is very small, it is very sensitiv when used as a voltmeter. This type of galvano meter, however, is not so sensitive as a mirror, or a a string, galvanometer. In our opinion, its grea advantages lie in its robust construction, and in th fact that its internal resistance is small. It should prove useful for pyrometric and similar work.

Messrs. J. W. Atha and Co., of 8 Southampton Row W.C.1, are the London agents for Messrs. Carl Zeiss.

Some Aspects of Russia's Contribution to Chemistry.

PROF. W. P. WYNNE, in his presidential address to the Chemical Society (1924, 125, 997-1013), gives an extremely interesting account of the work of Russian chemists up to 1914, dealing mainly with the Kazan University school of chemistry. The history of this school begins with the appointment in 1835 of Claus, the discoverer of ruthenium, as its first professor of chemistry, succeeded two years later by Zinin, who remained in this position until transferred to Petrograd in 1848. To this worker we owe the discovery of some of the fundamental reactions of aromatic organic chemistry,

sch as the preparation of aniline, α-naphthylamine, -phenylenediamine from the corresponding nitro-mpounds by reduction with ammonium sulphide, also the production of azoxybenzene, azobenzene d benzidine by modification or development of e above process.

Butlerov, who succeeded Zinin, is remarkable, t only for his far-reaching researches in the field structural chemistry and for the introduction of merous fundamental conceptions now universally ployed in the theory of organic chemistry, but so for his influence in forming an entire school of emists who, up to the present day, have actively llowed up and enlarged upon his work. Butlerov's st paper deals with the preparation of trioxy-ethylene and hexamine, and it was in the course this work that the first clue to the possible mechan-m of sugar synthesis in plants was found, namely, ie preparation of a mixture of hexoses from trioxy-ethylene. In the course of his next investigation isomerism and isomeric changes, Butlerov sug-ested the possibility of the phenomenon of tauto-erism which was later to occupy so prominent a lace in organic chemistry, and incidentally explained ie nature and the importance of the zinc methyl eaction, which, as a result of this work, occupied prominent place in processes of synthesis, until perseded by the Grignard reagent. A further con-equence of this work was the demonstration of the ossible stability of compounds possessing two ydroxyl groups attached to the same carbon atom, nd this was further substantiated by the synthesis f pinacolin from trimethylacetyl chloride. The xplanation of the course of reactions of polymerisa-ion in the olefine series must also be attributed to Butlerov, and it is noteworthy that in his investiga-ion on the di*iso*butylenes he again puts forward he idea of tautomerism.

Among the numerous workers who received their nspiration from Butlerov, perhaps the best known s Markovnikov, the enunciator of the well-known ule which bears his name. His work on the naph-henes is, however, no less important to chemistry han the above rule, and furnishes a classic example f the perseverance and capability of overcoming ifficulties so characteristic of Russian chemists. This research, together with those of Wreden at Petrograd and Kijner at Moscow, were instrumental n placing the study of the alicyclic compounds on he same level as that of other hitherto better known ubstances.

Markovnikov was succeeded in 1871 by A. N. Saytzev, who remained as professor of chemistry at Kazan until his death in 1909. Much of Saytzev's work was a continuation of his predecessors', dealing with the systematic synthesis of alcohols by the zinc alkyl process. G. Wagner is probably the most brilliant of Saytzev's students. This worker extended Saytzev's method for the preparation of secondary alcohols from ethyl formate by substituting for the latter various aldehydes, thereby obtaining ketones, which served as material for the testing of Popov's rule as to the oxidation of ketones. As a result of this work, Wagner was able to show that this rule did not hold good in all cases, but had to be modified according to circumstances. Following up this research, he next studied the progressive oxidation of compounds possessing ethylenic bindings and showed the importance of oxidation reactions in locating the position of unsaturated linkings in olefinic chains. In this way he was able to assign to oleic acid the structural formula now accepted. A consequence of this work was the view that oxidation of fatty acids occurs in the β-position, thus anticipating by sixteen years Knoop's theory of β-oxidation. The application of these oxidation methods to the study of the terpenes occupied the last twelve years of Wagner's life, and enabled him to assign to pinene, terpineol, dipentene, bornyl chloride, bornylene, and camphene their respective formulæ.

Similar work to that of the Kazan school was in the meantime also being carried out at Petrograd, Moscow, and Kiev, where Ipatiev, Zelinski, Favorski, and others studied the reactions of unsaturated hydrocarbons. Ipatiev was the first to synthesise isoprene by a method which gave clear evidence of its structure, and is also known for his work on the structural changes occurring in the unsaturated hydrocarbons obtained by the catalytic dehydration of alcohols. Zelinski investigated the *cyclo*-paraffins and olefines, whilst Favorski was the discoverer of the change which the homologues of allylene undergo on heating with alcoholic caustic alkalis. Kutcherov was the discoverer of the catalytic conversion of homologues of acetylene into aldehydes and ketones, thus opening the way to the production of acetic acid from carbide.

Mendeléeff is undoubtedly the best known of Russian chemists, and his paper on the periodic classification of the elements is too well known to require description, and the same may be said of the work of Beilstein and Menschutkin.

Prof. Wynne closes with a plea for a better appreciation of the value of the Journal of the Russian Physical-Chemical Society, and suggests that a study of this journal would amply repay the trouble incident on acquiring a sufficient knowledge of Russian.

The Kerr Effect in Optically Active Liquids.

WHEN polarised light passes through an optically active liquid in an electrostatic or a magnetic field the phenomenon of double refraction observed with a non-active substance is complicated by the optical rotation, and the only method employed to study the birefringence has been to mix equal quantities of right- and left-handed samples of the compound to be investigated, so as to obtain a non-active liquid. M. R. de Mallemann, in the *Annales de Physique* for July-August, making use of the Airy-Gouy principle that on the element of path *dl* the double refraction and the rotation act independently of one another, and that the resultant effect can be calculated by compounding the elementary vectors representing the two effects, derives formulæ by means of which the true double refraction of the liquid can be derived from the observations. Measurements are described on pinene, turpentine, ethyl tartrate, carvone and camphor, in which Panthener's method of instantaneous charge was used, which, in spite of certain difficulties, gives fairly satisfactory results in all cases, and enables the birefringence of imperfect insulators to be determined.

In almost all cases the Airy-Gouy principle gives, qualitatively, the relation between the phenomena; and, in general, there is quantitative agreement even with bodies like carvone, which have very large birefringence, the calculated ellipticities not differing in the majority of cases from those observed by amounts exceeding the limits of precision of the measurements. For the rotation of the axes, however, the differences in the case of carvone are more systematic.

M. de Mallemann considers the theories of Stark,

Oseen and Born, in connexion with his own previous work, which explained optical activity in terms of the asymmetry of the molecule; he does not, like the above authors, assume resonance, but uses the single idea of the asymmetry of the field of force, taking into account the experimental data. The theory indicates, in apparent agreement with observation, that the rotary power should increase when the number of atoms is large, when the masses and atomic volumes are large, and when the atoms are arranged very unsymmetrically. It also shows that the rotary dispersion is related to the refractive dispersion; and the specific rotary power should, in general, diminish with increase of temperature, and should increase with the pressure. There are, however, certain discrepancies in passing from the liquid state to that of vapour. Modifications of the molecular structure due to lack of rigidity of the molecule, which would not affect the refractive index, may produce marked changes in the optical activity, and the rotary power must be a very delicate index of molecular phenomena. This accounts for the difficulty of finding simple laws connecting the phenomenon as observed in different substances. The theory indicates that the Airy-Gouy formula can no longer hold rigorously for high refractivity; apparently this commences to be true in the case of carvone.

Engineering and Shipbuilding.

IT is not easy to state reasons for the present depression in the engineering and shipbuilding trades without touching upon political matters, and both Mr. J. Howden Hume and Mr. Tom Westgarth found this difficulty in their presidential addresses to the Institution of Engineers and Shipbuilders in Scotland and the North-East Coast Institution of Engineers and Shipbuilders respectively. Still in both addresses there is much of interest and several valuable suggestions.

Mr. Hume attributes the depression to (*a*) the loss of our export trade; (*b*) the Washington Treaty, which has seriously affected not only workmen engaged in engineering and shipbuilding, but also those on the technical and scientific staffs, and those connected with allied trades, besides the artisans in districts where warship building was carried out; (*c*) the world's market on the merchant shipping side has partially collapsed, and there was over-production of merchant ships during and immediately after the War.

Mr. Hume suggests (i.) that the whole question should be taken out of the political field and placed in the hands of a representative body, chosen, say, by half-a-dozen of the leading judges, and comprising equal numbers of manufacturers, workmen, merchants, and professional men. Such a body would arrive at the truth, and a plan could be devised and acted upon by the Government in power. (ii.) A complete and friendly understanding between employer and employed. The Shipping Federation and the National Sailors' and Firemen's Union have worked together for thirteen years, and in that time there has been no strike in the shipping trade. Other bodies might follow this lead.

The subject of Mr. Westgarth's address was waste. Of all sources of waste in industry, the greatest is that caused by strikes and lockouts, by demarcation difficulties between trades, and by people of all classes not doing a fair day's work for a fair day's pay. Many disputes are the result of neglect and delay in dealing with difficulties as they arise, and something of the old-fashioned discussion between master and workmen immediately a difficulty appears should be revived. Such discussion should be informal and n binding on the official representatives of either sid By this method a great many disputes would probab never be taken outside the works. In 1921, 85,872,0 working days were lost through disputes, a 10,642,000 in 1923, according to the Ministry Labour Gazette. Nearly all this waste is preventabl and could be prevented by friendly conference. S Robert Hadfield's suggestion that an endeavo should be made to arrange an industrial truce worthy of the most serious consideration.

Mr. Westgarth referred to a fruitful cause of unrest wages in the so-called protected trades do not co pare reasonably with those in the highly skilled an competitive trades. If competition in the ope markets of the world makes it impossible to pa skilled workmen a certain wage, it is in the highe degree wasteful to pay considerably higher wages t unskilled men just because a stoppage of their wor would be an inconvenience to the public. This reall amounts to a kind of blackmail, and the public shoul be assisted in resisting such claims by their governin representatives.

In reference to technical waste, Mr. Westgarth say that the engineering industries can only be success fully conducted nowadays by helping to make possibl the discovery of new methods of manufacture an fostering the advancement of new ideas in engineerin science—as distinct from teaching engineering scienc —and then by giving commercial expression to th best of such methods and ideas. Has such a polic been characteristic of British engineering? Th future of British engineering will be good or bad according as the spirit of scientific progress develop or flags.

Electrical Precipitation.[1]

THE two kinds of electrical precipitation dealt with were the natural and the artificial. Artificial precipitation began with the well-known experiment which Sir Oliver Lodge showed to the British Association at Montreal in 1884 on the electrical deposition of smoke or steam; an observation which has now been applied on a large scale in Great Britain, by his sons and by Dr. Cottrell in the United States, to the recovery of metallic fume, and to the freeing of blast-furnace gas from solid material before combustion. The theory of the action is like that of the coherer, and was considerably elucidated by the late Lord Rayleigh's experiments on the cohesion of liquid jets and drops, under slight electrical stimulus.

The natural kind of electrical precipitation is what occurs in the atmosphere when clouds turn into rain; and also when, as shown by Dr. G. C. Simpson, large water-drops break up in a column of ascending air, giving rise to separation of electricities and the phenomenon of thunderstorms. This mode of generating electricity is somewhat surprising. A theory of it is suggested by the coherer and water-drop experiments; since the breaking-up of a drop may be regarded as the converse action to the cohesion of two drops. Electrical influence stimulates cohesion: it is possible that absorption may give rise to electrical separation. Not that the two fragments become oppositely electrified, but because the uniting electronic layer is blown away by the air, thus carrying away a negative charge and leaving the residual water positive. Calculation applied to this phenomenon seems to give results of the right order of magnitude, making use of Dr. Simpson's measurements of the charge which can thus be imparted to the fragments

[1] Abstract of an address by Sir Oliver Lodge, F.R.S., delivered on Wednesday, October 29, to the Institute of Physics.

a drop of water of known size, falling through or to a blast of air.

Returning to the artificial electrification of solid or liquid particles, Sir Oliver emphasised the engineering skill which had enabled very high-tension electricity to be applied, in difficult circumstances, continuously throughout the year; and mentioned the economical value of the results. He then proceeded to ask whether the natural operations occurring in the atmosphere would always remain beyond human control; or whether precipitation of moisture could not be taken in hand and managed—in ways which seemed no more difficult or unmanageable than the modern theory and treatment of disease; a subject which, like the weather, was at one time left to pious resignation or appeal, without any adequate effort being made to take it in hand and control it.

University and Educational Intelligence.

CAMBRIDGE.—Lady Teall has presented to the Sedgwick Museum the very valuable collection of rocks and rock-slices made by her late husband, Sir Arthro Teall, St. John's College.

Dr. M. B. R. Swann, Gonville and Caius College, has been reappointed demonstrator of pathology.

Mr. F. P. Ramsey, Allen student and scholar of Trinity College, has been elected to a fellowship at King's College.

The Henry Sedgwick Memorial Lecture will be given at Newnham College by Sir J. J. Thomson, Master of Trinity College, on Saturday, November 29, at 5 o'clock. The title of the lecture is "Radiation."

LONDON.—A University chair of anatomy, tenable at the Middlesex Hospital Medical School, has been instituted as the result of a munificent gift of 20,000*l.* by Mr. S. A. Courtauld; the title of the chair will be "The S. A. Courtauld Chair of Anatomy"; and Dr. Thomas Yeates, at present University professor of anatomy at the School, has been appointed as the first occupant.

The Sir John William Lubbock Memorial Prize in mathematics, of the value of 30*l.*, has been awarded to Miss E. M. Jones, of the Royal Holloway College.

The following doctorates have been conferred: D.Sc. (*Physics*): Mr. W. N. Bond (University College and the Imperial College—Royal College of Science), for a thesis entitled "The Flow of Fluids treated Dimensionally"; D.Sc. (*Chemistry*): Mr. G. E. Foxwell, for a thesis entitled "Collected Researches into By-Product Coking," and another paper; and Miss F. M. Hamer, for a thesis entitled "The Synthesis of an Azocyanine," and other papers.

Prof. H. B. Baker has been appointed representative of the Faculty of Science on the Senate for the remainder of the period 1921–25 in succession to Prof. A. N. Whitehead, who has accepted a chair in the Faculty of Philosophy at Harvard University.

APPLICATIONS are invited for the Wernher Beit chair of pathology in the University of Cape Town. The applications, eight in number, should be sent by, at latest, November 18 to the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2.

A LECTURER in mechanical engineering is required at the University of Cape Town for twelve months dating from March 1 next. Candidates must be qualified to give instruction on machine drawing and design and the theory of machines. Applications should be sent by November 7 at latest to Prof. Gillick, Royal College of Science, South Kensington, S.W.7.

APPLICATIONS are invited for the principalship of the Wigan and District Mining and Technical College in succession to Mr. S. C. Laws, recently appointed principal of the Northampton Polytechnic Institute, Clerkenwell. The latest date for the receipt of applications is November 29. They should be sent to the chairman of the governing body of the college.

THE council of the Royal Horticultural Society has decided to contribute 105*l.* to the fund which Lord Milner is raising for the Imperial College of Tropical Agriculture. This is a gratifying indication that the premier horticultural society in the world recognises the value of the work that the College is doing for agriculture in the tropics.

A LECTURER in psychology and philosophy will be required in February next at the Rhodes University College, Grahamstown, South Africa. Particulars may be had from the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2. Applications for the post should be sent not later than November 5 to the Master, Balliol College, Oxford.

THE North of Scotland College of Agriculture Calendar for 1924–25 includes reports on the past year's work, showing that the county extension classes were well attended. The rapid development of the work is shown by the record of attendances during each of the past five years at the systematic classes in agricultural subjects in the extension area of the College: 3035, 13,166, 18,786, 23,436, 33,849. The Central Class report, on the other hand, shows a decrease in the enrolments for degree courses in all subjects except agricultural botany and agricultural zoology. The Edinburgh and East of Scotland College of Agriculture also shows a decrease in the number of students attending Central Classes under each of the heads: day classes, evening classes, rural schools' course, and farmers' class. The College has now entered into possession of its experimental farm of 600 acres at Boghall, and the publication of college reports and leaflets, which has for some time been discontinued, will, one may surmise, be resumed. The list of appointments held by former students shows that appointments were obtained in 1923 in Scotland (2), England (2), Ireland, Hungary, West Africa, Tanganyika, India, Singapore, and Argentina.

HONOURS courses have been established recently in many American universities and colleges with the object of releasing the more highly gifted undergraduates from the trammels of a system designed to meet the needs of the average student. The National Research Council collected material in the shape of reports and suggestions and turned it over to President Aydelotte, of Swarthmore College, who has prepared a critical summary, published by the Council as Bulletin No. 40. In thirty colleges and universities, honours candidates are now required to undertake specific extra tasks, a special course, a thesis, or a comprehensive examination, in addition to doing substantially the same amount of work in regular courses as is done by the pass-men. In nine there are, or will shortly be, in operation schemes for honours based on work superseding the regular requirements during a part, generally the third and fourth years, of the undergraduate course, following a creditable record in the work of the first two years. The honours student has his work outlined for him, not, like the pass-man, in terms of what he must do, but in terms of what he must know. Instead of taking courses he studies a subject. In nearly all cases provision is made for individual supervision and instruction by competent teachers, but not for any great number of special honours lectures or classes.

Early Science at the Royal Society.

November 2, 1664. Dr. Wilkins related that Sir John Cutler had declared to him, that he was firm in his resolution to settle upon Mr. Hooke 50*l.* per annum for such employment as the Royal Society should put him upon.—A letter of Mons. Huygens to Sir Robert Moray was read, containing a relation of his having seen with wonder at Paris a glass of twelve foot of the workmanship of Divini, which bore the aperture of two inches Parisian measure; upon which occasion he recommends it as a matter worthy of inquiry, to know what may be the right aperture in each glass, of such and such a distance from the focus.

1671. Mr. Oldenburg presented to the Society from Mr. Hobbes his "Rosetum Geometricum," printed at London, addressed by him to the Royal Society for their judgment thereon: Which pieces were referred to the consideration of the professors of Astronomy and Geometry in Gresham-college, and Mr. Collins.

November 4, 1663. The history of whale-fishing, and of the making of whale-oil, was delivered in by the secretary from Mr. Gray of the Greenland Company, who had been in those parts, and was present at the killing of whales and the making of oil.

November 5, 1667. It was mentioned by Mr. Oldenburg, that Sir Paul Neile had spoken to him, that Mr. Adrian May had desired, that the society would give order for a good thermometer for the use of the Queen.—Dr. Wilkins moved, that Mr. Collins might be declared exempt from the payment of admission-money and the weekly payments, he having but a small revenue, and being capable and willing to do the Society very good service. He was declared exempt accordingly.

November 6, 1672. Mr. Hooke mentioned that among Mr. Guericke's experiments there was one which he thought deserved to be tried before the Society, viz., that of a sulphur-ball having a considerable attractive power, and representing the properties of the earth. Mr. Locke intimated that himself had made some experiments with such a ball.

1673. The earl marshal, who was present was acquainted by the council with their thoughts of removing their weekly assemblies to Gresham College, and of beginning to meet there again upon the next anniversary election-day; as also by the solemn invitation of the city of London, and the professors of Gresham College. To which was added, that though this Society should thus remove their meetings, yet they were full of hopes that his lordship would be so far from removing his favours and kindnesses from them, that he would preserve them in the same degree that he had done all along, and especially during the many years he had entertained them under his roof. Whereupon the earl marshal very obligingly and generously declared that though they had been a great honour to his roof, he could not but give up his reason to the reason of the council.

November 7, 1666. Sir Robert Moray proposed, that the directions for seamen, and the inquiries of tides, might be printed separately, and the instruments mentioned in the printed papers concerning these particulars provided both at the society's expence; and promised, that he would endeavour to procure an order from his Royal Highness the duke of York to Trinity-house, importing, that every captain and master of a ship should take with them in their voyages a copy of such printed books, and make observations and trials accordingly; of which they should at their return give one to Trinity-house, and another to the society.

Societies and Academies.

LONDON.

Royal Meteorological Society, October 15.—M. C. J. P. Cave, president, in the chair.—L. F. **Richardson**: The brown corona and the diameters of particles. As a result of experiment the following variety of Airy's formula has been found to be in rough agreement with measurements on various holes and spheres:

$$\text{(diameter of obstacle)} = \frac{5{\cdot}3 \times 10^{-5}\ \text{cm.}}{\sin\left\{\text{(radius of chestnut-brown corona)} - \tfrac{1}{2}\text{(radius of source)}\right.}$$

In view of Ray's work this will not be applicable to the smallest cloud-droplets of 2 microns diameter but is more likely to apply to drops of ordinary size, of, say, 5 to 20 microns diameter.—L. F. **Richardson**: Photometric observations on clouds and clear skies. With an improved instrument made at Benson, it was shown that the difference-of-brightness at the moon's-limb, as measured by the instrument, is independent of the glow of the sunlit sky. It was also shown that the transparency of blue sky alters during twilight. Observations on clouds enable one to compute the rainfall equivalent to the cloud on those occasions when a corona reveals the size of the droplets; a certain very dark thunder-cloud was like a rain-factory holding in stock only one hour's output.—L. J. **Sutton**: Notes on haboobs. Haboobs are severe sandstorms of a type apparently confined almost entirely to the Sudan, where they are most frequent in the central region. Nearly all of them occur during the rainy season, *i.e.* May to October, and at Khartoum, for example, they are experienced more than once a week during this period and last about three hours on the average. Haboobs probably owe their origin to the heating up of a large region for four or five days, but owing to the wide distances between meteorological stations in the Sudan, it has not been possible to discover where any particular haboob originated or to follow its track.

MANCHESTER.

Literary and Philosophical Society, October 21.—G. **Senn**: The change of position of the chlorophyll grains in the plant cell. Green chlorophyll grains show positive and negative phototactic reactions to red and green light, if it is strong enough or if the sensitiveness of the grains is raised by lower temperature. The various colouring substances appearing in the chlorophyll grains of different Algæ (yellow in diatoms, brown in Brown Algæ, and red in Red Algæ) generally do not influence their phototactic irritability. A Red Alga was only slightly more sensitive to green light of diffuse intensity. In high intensities of direct sunlight the red rays induce a very strong effect on the grains of the majority of Brown Algæ (five of six species) and of the only Red Alga studied. But as the yellow light with its shorter rays produced much weaker effects, the strong action of the red rays must have been produced by a damaging action on the protoplasm which transported the grain by its streaming. In this case the grains are passive during their movement like those of Elodea and Vallisneria during the rotation of the protoplasm. It seems that it is only the colourless protoplasmic strands of the envelope of the green chlorophyll grains which execute their normal movements.

PARIS.

Academy of Sciences, September 29.—M. Louis Bouvier in the chair.—Mme. Sylvia **Creanga**: The cyclifying developable surfaces of a curve and

their application to the theory of curves traced upon a surface.—Th. **Varopoulos**: The differentials of multiform functions.—A. **Foch**: The use of Recknagel's disc as an indicator of velocity and direction. Predetermination of the constant for a Recknagel's disc and suggestions for possible applications.—J. G. **Stokvis**: Conversion of the energy of a triphase system or a constant energy to a pulsatory energy.—André **Léauté**: The propagation of electric waves along perfectly insulated iron wires, taking account of the skin effect.—H. **Gault** and H. **Klees**: Contribution to the study of the condensation of acetoacetic esters with malonic esters. Preliminary results of the products of the interaction of α-chloracetoacetic ester with the sodium derivatives of cyanacetic ester and of malonic ester.—G. C. **Georgalas**: The geological constitution of the Phourni Islands (between Nikaria and Samos).—**Munerati**: The running to seed of beetroot in the first year. The conditions under which the beetroot may behave as an annual or a biennial are not known with certainty and are not under control. Examples are given of the slight changes in external conditions which may cause the change from annual to biennial.—Jacques **Benoit**: Experimental endocrinian hypomasculism in the domestic cock.—Jean **Bathellier**: The development of *Macrotermes gilvus* compared with that of *Eutermes rantangensis*.—**Parat** and J. **Painlevé**: Vital observation of a glandular cell in activity. The nature and rôle of Golgi's internal reticular apparatus and Holmgren's apparatus.

October 6.—M. Louis Bouvier in the chair.—P. **Villard**: The experiments at Courtine. The dominant waves produced by a very powerful explosion are, even at a short distance, of very low frequency, well below the audible limit: the sound is the result of a secondary phenomenon of relatively negligible importance. It is quite certain that the mechanical effects, such as breaking windows, observed in the neighbourhood and up to several kilometres distance from a powerful explosion, must be attributed to waves much longer than the ear can perceive.—G. **Sagnac**: The mechanism of light projection in double stars.—A. **Grumbach**: The rôle of ionisation in cells with fluorescent liquid.—Charles **Nordmann**: The utilisation of the grapho-mechanical combiner for numerous everyday problems in physics.—W. **Kopaczewski**: The effects of dilution on colloids. In determining the physico-chemical constants of blood serum, it has been found that the diluted sera possess a conductivity sensibly higher than would be expected from the law of electrical dissociation. Other colloids (hæmoglobin, collargol, electrosol of calysed silver and gold, Paris violet, etc.) have now been examined and have proved to show the same phenomenon. Some consequences in physical chemistry, biology, medicine and therapeutics are deduced.—E. **Darmois** and A. **Honnelaitre**: Some properties of ammonium dimolybdomalate. This salt is a reagent for substances capable of combining with molybdic acid: these produce considerable variations in the rotatory power.—A. **Lassieur**: The electrolytic separation of copper, antimony, and bismuth from lead. The separation is effected in hydrochloric acid solution, with or without addition of hydrofluoric acid, in the presence of hydroxylamine hydrochloride, and using the method of graded potentials.—Mme. Pauline **Ramart**: The action of hydrobromic acid on some tertiary alcohols. Alcohols of the general formula $(C_6H_5)(OH)(Ar) . C . CR_1R_2R_3$ are readily transformed into unsaturated hydrocarbons by the action of HBr in glacial acetic acid solution.—**Fosse** and A. **Hieulle**: A colour reaction, hitherto supposed to be characteristic of formaldehyde, produced by glyoxylic acid.—Marcel **Mirande**: The states of liliosterin in the course of the life of the bulbar scales of the white lily.—P. **Reiss**: Remarks on the internal P_H of the cell nucleus and its experimental variations.

ROME.

Royal Academy of the Lincei.—Papers received during the vacation.—Giacomo **Albanese**: Conditions for the rationality of the variety of pairs of points of two distinct or coincident algebraic surfaces.—Luigi **Fantappiè**: The nth prime number as the asymptotic value of a function $\psi_n(s)$ deduced from the $\zeta(s)$ of Riemann.—Oscar **Zariski**: Algebraic equations containing linearly a parameter and resolvable by means of radicles.—Bonaparte **Colombo**: An extension of Lamé's problem regarding the distribution of temperature in an ellipsoid having three unequal axes.—Washington **Del Regno**: Relation between the elastic tension and the magnetic behaviour of nickel steels in the neighbourhood of the transformation point. The relationship between the elastic and the magnetic behaviour shown by nickel is found also with three nickel-iron alloys, two of these being reversible and the other irreversible.—S. **Berlingozzi** and G. B. **Capuano**: 3-Hydroxyquinoline-4-carboxylic acids.—F. **De Carli**: Reducibility of certain metallic halides by means of hydrogen.—Remo de **Fazi**: A new reaction of aldehydes.—G. **Malquori**: Electrolytic preparation of ozone by means of an alternating current superposed on a continuous current.—Emilio **Papasogli**: Derivatives of diphenylamine.—Mario **Passerini**: Reaction between pernitrosocamphor and potassium cyanide. This reaction is one of direct addition of a molecule of each of the reacting compounds, the result being a potassium salt, the potassium of which may be replaced by other elements, such as copper or silver.—Ubaldo **Sammartino**: Studies on insulin: II. Action of insulin on zymase. The experimental results obtained lead to the conclusion that the active principle of the pancreas exerts no appreciable influence either on the fermentation of sugars by Saccharomyces or on glucolysis by zymase.—V. **Tognazzi**: Chalkones and hydrochalkones.—Mario **Ferrari**: Datolite from Monte Campotréra (Reggio Emilia).—Roberto **Savelli**: Transmission of mutations through inter-specific hybridisations.—Livia **Garofolini**: Utilisation of *Triton cristatus* for the destruction of the larvæ of Anopheles. *Triton cristatus* destroys, but is not a specific enemy of, Anopheles larvæ.—Luisa **Volterra**: Variability of the pelagic Daphnias of the lakes of Albano and Nemi.—G. **Amantea**: Periodic and cyclic modification of the uterus of Canis, independent of pregnancy.

Official Publications Received.

Ministry of Health. Final Report of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food. Pp. 84. (London: H.M. Stationery Office). 1s. 6d. net.

The Newcomen Society for the Study of the History of Engineering and Technology. Transactions, Vol. 3, 1922–1923. Pp. xii+140+21 plates. (London: Science Museum, South Kensington.) 20s.

Department of Scientific and Industrial Research. Report of Test by the Director of Fuel Research on Parker Low Temperature Carbonisation Plant installed at Barugh, Barnsley, at the Works of Low Temperature Carbonisation, Ltd. Test carried out July 22nd to 24th, 1924. Pp. iv+24. (London: H.M. Stationery Office.) 9d. net.

Empire Cotton Growing Corporation. Report of the Administrative Council of the Corporation to be submitted at the Third Annual General Meeting on October 23rd, 1924. Pp. 22. (Manchester.)

Report of the Council of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne, intended to be presented at the Annual Meeting of the Society, 7th November 1924. Pp. 34. (Newcastle-upon-Tyne.)

The University of Leeds. Calendar, 1924–25. Pp. xxxii + 573. (Leeds.) 4s.

County Borough of Warrington: Museum Committee. Report of the Director of the Museum for the Two Years ending 30th June 1924, with a List of the principal Additions to the Museum Collections. Pp. 20. (Warrington.)

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Supplement to the Minutes of Proceedings of the Institution. Edited by W. F. Spear. New Series, No. 21, October. Pp. 193. (London: Great George Street.)

Dominion Museum. Monograph No. 7: A Bibliography of Printed Maori to 1900. By Dr. Herbert W. Williams. Pp. xvi+198. (Wellington, N.Z.: W. A. G. Skinner.)

Diary of Societies.

SATURDAY, NOVEMBER 1.

GILBERT WHITE FELLOWSHIP (at Queen Square, W.C.), at 3.—Sir A. Daniel Hall: The Countryside in English Literature (Presidential Address).

MONDAY, NOVEMBER 3.

ROYAL SOCIETY OF EDINBURGH, at 4.30.

ROYAL INSTITUTION, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—Capt. W. J. Liberty: Underground London.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Public Library, Swansea), at 6.—R. G. Isaacs and others: Discussion on Power Factor Improvement.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—H. H. Harrison: Chairman's Address.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.), at 8.—Prof. A. D. Lindsay: What does the Mind construct? (Presidential Address).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—W. J. U. Woolcock: Experiments in Protection.

LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (at Leicester Museum), at 8.—Prof. H. H. Swinnerton: Man 100,000 B.C.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presidential Address.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Sir Aurel Stein: Innermost Asia: Its Geography as a Historical Factor (First Asia Lecture).

TUESDAY, NOVEMBER 4.

ROYAL HORTICULTURAL SOCIETY, at 4.—Lecture.

MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—Anniversary Meeting.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—C. M. Hunter: The Oilfields of Argentina.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Sir A. Smith Woodward: Exhibition of a Plaster Cast of a Fossil Egg of a Dinosaur.—D. Seth-Smith: Exhibition of Rare Amazon Parrots from Dominica and bower of Australian Regent-Bird.—S. Hirst: Three new Acari belonging to the Superfamily Trombidioidea (Erythræidæ and Teneriffiolidæ).—I. Montagu: (1) The Remains of Fen-Beaver in the Sedgwick Museum; (2) The Burrows of the Rodent Spalax.—R. Gurney: The Larval Development of some British Prawns (Palæmonidæ). II. *Leander longirostris* and *Leander squilla*.—W. E. Le Gros Clark: The Brain of the Tree-Shrew, *Tupaia minor*.

INSTITUTION OF CIVIL ENGINEERS, at 6.—B. Mott: Address.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Midland Hotel, Manchester), at 7.—H. C. Lamb: Chairman's Address.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, New Street, Birmingham), at 7.—A. R. Page: Brazing.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. D. Johnston: Presidential Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Section) (at Broadgate Cafe, Coventry), at 7.15.

INSTITUTE OF METALS (North-East Coast Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—W. E. W. Millington: The Structure of Metals in its relation to Elastic Failure. Part II.

RÖNTGEN SOCIETY (at British Institute of Radiology, 32 Welbeck Street, W.), at 8.15.—Dr. A. E. Barclay: The Growth of Radiology: Has the Röntgen Society kept pace with it? (Presidential Address).

WEDNESDAY, NOVEMBER 5.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. F. X. Schaffer (of the State Natural History Museum, Vienna): History of the Vienna Basin (Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—E. H. Shaughnessy: Address.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Engineers' Club, Coventry Street, W.), at 7.—E. S. Shoults: The Heating and Ventilation of Glass Houses from the Grower's Point of View.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section) (at University College, Nottingham), at 7.30.—C. E. Pickard: The Testing of Bates in the Laboratory.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.—W. S. Hoseason: Notes on the Malaria Parasite.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Dr. H. E. Cox: Certain New Methods for the Estimation of Arsenic and its Occurrence in Fish and Urine.—A. T. Etheridge: The Estimation of Cadmium in Brass.—N. C. Wright and J. Golding: The "Hoyberg" Method of Milk and Cream Testing.—Dr. S. G. Willimott: An Apparatus for the Catalytic Dehydrogenation of Alcohols.

ROYAL SOCIETY OF ARTS, at 8.—Senatore G. Marconi: Address.

INSTITUTION OF CHEMICAL ENGINEERS (at University College), at 8.—Dr. M. W. Travers: The Water Gas Process.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, NOVEMBER 6.

ROYAL SOCIETY, at 4.30.—Prof. T. R. Merton: Ultraviolet Spectrophotometry.—Prof. W. L. Bragg and Prof. S. Chapman: A Theoretical Calculation of the Rhombohedral Angle of Crystals of the Calcite Type.—Prof. O. W. Richardson and T. Tanaka: (1) The Striking and Breaking Potentials for Electron Discharges in Hydrogen; (2) On A, P, Q and R Combination in the Many Lined Spectrum of Hydrogen.—J. D. Bernal: The Structure of Graphite.—*To be read in title only*:—C. N. Hinshelwood and R. E. Burk: The Homogeneous Thermal Decomposition of Nitrous Oxide.—C. N. Hinshelwood: The Kinetics of the Interaction of Nitrous Oxide and Hydrogen.—Dr. A. T. Doodson: Perturbations of Harmonic Tidal Constants.—K. R. Ramanathan: The Structure of Molecules in relation to their Optical Anisotropy. Part I.—Prof. J. W. Wood: Controlled Orbital Transfers of Electrons in Optically Excited Mercury Atoms.

LINNEAN SOCIETY OF LONDON, at 5.—E. G. Baker: A Remarkable Tree of African Leguminous Plant.—Prof. E. B. Poulton: Exhibit of Lantern Slides illustrating Mimicry among Fijian Butterflies.—Dr. H. A. Baker: Cestodes from Whales.—W. H. Pearsall and Dr. W. H. Pearsall: Phytoplankton of the English Lakes.—Dr. B. M. Griffiths: Studies in the Phytoplankton of the Lowland Waters of Great Britain: the Phytoplankton of Shropshire, Cheshire, and Staffordshire.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Sir St. Clair Thomson: Tuberculosis of the Larynx and its Significance to the Physician (Mitchell Lecture).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—R. Johnson: Some Clinical Aspects of Carcinoma of the Breast (Bradshaw Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. D. Cockcroft, E. Coe, J. A. Tyacke, and Prof. Miles Walker: An Electric Harmonic Analyser.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Westminster House, Adelphi), at 7.30.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (Joint Meeting with the Institute of Chemistry) (at Bristol University), at 7.30.—F. Holmyard: The Present Position of the Geber Problem.

CHEMICAL SOCIETY, at 8.—J. Kenyon, H. Phillips, and H. G. Turner: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XXIV. Further Experiments on the Walden Inversion.—Prof. T. M. Lowry: Studies of Valency. Part V. The Mechanism of the Walden Inversion.—H. J. Emeléus and W. R. Downey: A Spectroscopic Study of the Luminescent Oxidation of Phosphorus.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at —Joint Discussion with the Section of Epidemiology and State Medicine and the Society of Medical Officers of Health, on The Notification of Puerperal Sepsis.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Section) (at Glasgow). —Prof. J. H. Andrew: Steels and their Selection.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Section) (at Manchester).—Prof. W. T. David: (*a*) The Missing Pressure in Gas-Engine (*b*) Heat Loss in Gas-Engines.

FRIDAY, NOVEMBER 7.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion: International Geophysical Congress at Madrid. Chairman—Col. H. Lyons. Speakers—Sir G. P. Lenox-Conyngham, A. R. Hinks, Dr. Chree, R. G. K. Lampfert, Prof. H. H. Turner.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Vice-Admiral Sir George G. Goodwin: The Trend of Development of Marine Propelling Machinery (Thomas Hawksley Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—Sir William Willcox: The Influence of Chemical Research on Medicine and Forensic Medicine.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at —J. C. Dollman: Light.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—H. C. Jones: History and Construction of the Fire Engine.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduates' Section) (at Cleveland Institution, Middlesbrough), at 7.30.—R. W. Dickinson: Toothed Gearing.

PHILOLOGICAL SOCIETY (at University College), at 8.—Papers on New Liddell and Scott.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 1.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Famous Pharaohs.

MONDAY, NOVEMBER 3.

KING'S COLLEGE, at 5.30.—Prof. E. W. Scripture: The Psychoanalysis the Poet.

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on November 4, 6, 7.)

THURSDAY, NOVEMBER 6.

ROYAL SOCIETY OF MEDICINE (1 Wimpole Street, W.), at 3.—Dr. Guisez: Malignant Disease of the Gullet (in French) (Semon Lecture).

FINSBURY TECHNICAL COLLEGE (Leonard Street), at 4.—Julian L. Baker: The Chemist and the Fermentation Industries (Streatfeild Memorial Lecture).

ST. THOMAS'S HOSPITAL MEDICAL SCHOOL, at 4.30.—Prof. J. Mellanby: Enzymes. (Succeeding Lectures on November 13, 20, 27.)

FRIDAY, NOVEMBER 7.

KING'S COLLEGE, at 5.30.—Prof. E. W. Hobson: The Ideal Aim of Physical Science.

UNIVERSITY COLLEGE, at 5.30.—R. H. Hooker: The Weather and the Crop. Part II. Economic Effects (Jevons Memorial Lectures). (Succeeding Lectures on November 14, 21, 28.)—At 8.—Prof. G. Dawes Hicks: German Philosophy in the XIXth Century. (Succeeding Lectures on November 14, 21, 28; December 5, 12.)

SATURDAY, NOVEMBER 8.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: The Amulets of Ancient Egypt and of Modern London.

NATURE

SATURDAY, NOVEMBER 8, 1924.

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON

NO. 2871, VOL. 114]

Science and Philosophy.

THE different branches of knowledge are often classified according to their subject matter. To each is assigned a definite region of experience or a definite group of ideas; the conclusions of those who study these with special application are supposed to be embodied in a series of propositions which convey all that is known on the subject to any one whose interest may be aroused in it. Distinctions drawn on this basis between the various experimental sciences, or between science and mathematics or history, are accepted without question. The physicist gives his material to the chemist to be analysed, asks the mathematician to solve his equations, and inquires of the historian whether his result was known to the ancients; he recognises that these matters lie within their province, not his, and yet he has perfect confidence in their answers. The exact boundaries may sometimes be difficult to draw, and where they occur, disputes may arise between those who approach them from opposite sides; but there are large areas within which all are content to accept the jurisdiction of the recognised occupants.

But with philosophy the position is different. No student of science ever hands over any of his problems to a philosopher, or accepts gratefully from him any help that may be offered spontaneously; and yet the reason for his aloofness does not seem to be merely a diversity of subject matter so complete that the two studies can never enter into contact. For philosophers, who surely know what they are studying, undoubtedly believe that their studies have some bearing upon science; while the bewilderment which philosophic writings produce in most scientific minds is akin to exasperation rather than to indifference. If science and philosophy are distinguished by their subject matter, then either there are problems involving both provinces or there are not. If there are, why do we not work in friendly co-operation? If there are not, why do we quarrel?

In a recent lecture [1] Prof. Graham Kerr suggests that the distinction is one of method, not of matter; and if he is asked why two methods applied to the same matter do not lead to concordant results, he replies that one of them is wrong. We must reject entirely the "old philosophy" and replace it by the "new philosophy—Science." The view is not entirely novel, but it has at least the merits of frankness and directness. It is scarcely a solution of the difficulty. For it cannot be expected to appeal to philosophers; and even those whose sympathies are wholly scientific may be loath to believe that the labours of so many men not obviously

[1] "Science—The New Philosophy," Proc. Roy. Phil. Soc. Glasgow, 52, 187 (1924).

devoid of intelligence have been so entirely futile; it leaves the question why there is a conflict between science and philosophy exactly where it was. But perhaps our chief wonder will be why, if philosophy has hitherto been nothing but error, Prof. Kerr thinks that he exalts the importance of science by calling it philosophy.

The answer is probably to be found in history. Before knowledge was differentiated, and when all serious students were "philosophers," a solution of all the problems of philosophy would have answered all the questions which any of them cared to ask. We suggest that when Prof. Kerr calls science the new philosophy, he means simply that it answers all the questions that he cares to ask. If that is so, nobody will quarrel with him except on a point of mere terminology. But the question remains whether science will answer all the questions (including this one) which other people care to ask. Prof. Kerr recognises himself that there is a diversity of intellectual interest; he complains, for example, that philosophers are indifferent to improvements in observational methods, which interest him so greatly. Is it not possible that he is indifferent to things which interest them, and that in this diversity of interest, which leads to the asking of different questions, lies the true distinction between science and philosophy?

Let us consider from this point of view the problem which causes the fiercest contention, that of the reality of the material world. Science and philosophy are here concerned with the same subject matter, namely, the experience received through the senses. Are they asking the same question about it, or is there confusion arising from their common inheritance of the word "real"? The scientific question is to be answered ultimately by experiment. Now an experiment is simply a portion of experience which is regular in the sense that it can be repeated and can be experienced by all men at all times; improvements in observational methods are improvements or extensions of this regularity. It seems, therefore, that the question which science asks is whether and how far sense-experience can be reduced to or analysed into this kind of regularity. The supreme test of regularity is prediction; and it is easy, therefore, to understand why Prof. Kerr maintains that, to the man of science, the question of reality "was disposed of long ago when it was realised that occurrences in the external world could be prophesied."

Philosophers, however, are not interested in experiment; that is precisely the difference between students of philosophy and science; and therefore this cannot possibly be the question that they are asking. Many of us find it hard to discover what that question is; but it seems to arise from the contemplation of the irregularities of experience. Side by side with the regular portion of sense-experience which an observer shares with all men at all times, and inseparably entangled with it, there is an irregular portion which is peculiar to him at a particular moment and makes it *his* experience. It is almost impossible to frame any question about it in words or to understand a question framed by others for words, being a method of communication between different persons, are necessarily based on the common and regular portion of experience. But if any one can frame such a question, either for himself or for others, and if he finds it interesting, surely it is a legitimate subject of study. It is, however, a study concerning which science cannot possibly have anything to say and on which its conclusions and its success in prediction can have no bearing whatever.

If this view is right, when any one asserts that anything is real he means nothing more and nothing less than that he has been able to satisfy to some extent his intellectual aspirations. When we assert that atoms or electrons are real, we are not deciding between the philosophic doctrines of materialism and idealism because we have no understanding of those doctrines or interest in them. When also a philosopher asserts that time or space is not real, he is not throwing any doubt on any scientific doctrine; for the purpose of that doctrine, namely, to describe and explain the regularities of sense-experience, does not appeal to him. While this mutual lack of interest continues—and it is something very fundamental in the constitution of human minds—there can be no reconciliation between science and philosophy. For knowledge is what somebody thinks; science is what men of science think about, philosophy what philosophers think about; and while they continue to think about different things and ask different questions, no idea that is important to one can be important to the other.

Reality was not, however, the only problem of the "old philosophy" from which modern science and philosophy descend. Science, we agree, must solve this problem for its students; but can it solve the other problems, such as the nature of justice or of beauty? Prof. Kerr apparently thinks it can. The New Philosophy, he tells us, identifies greater human perfection with greater prosperity and happiness. But there are others, not less entitled to speak for science, who cannot accept the ideal of the contented pig, and would regard wisdom and virtue as no less important ingredients of perfection. When science speaks with divided voices, who shall decide? Philosophy, of course, say the philosophers; and our difference with them in the matter of reality need not make us unwilling to grant their claim. For if, as has been suggested, the philo-

ophic view of reality is based on the consideration of individual and irregular experiences, concerning which no two persons can agree and which are important for that very reason, surely it may throw some light on moral and æsthetic judgments, concerning which opinion is similarly diverse. If philosophy takes for her province those subjects round which, from their very nature, bitter disputes must ever range, we may be well content to leave her in possession and to share with mathematics and history the province of positive knowledge. Nor will she have reason to complain if we reject any conclusions that she may offer us; for our rejection will merely extend her sphere and offer her new fields to conquer. N. R. C.

Primitive Fishes and Petroleum.

(1) *The Evolution and Distribution of Fishes.* By Prof. John Muirhead Macfarlane. Pp. ix+564. 25*s.* net.
(2) *Fishes: the Source of Petroleum.* By Prof. John Muirhead Macfarlane. Pp. ix+451. 25*s.* net.
(New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.)

(1) THESE two very interesting books by the professor emeritus of botany in the University of Pennsylvania form an aftermath of his early studies of the fossils of the neighbourhood of Edinburgh. In his previous volume, "The Causes and Course of Organic Evolution," he propounded the thesis that "organisms evolved first in fresh-water areas, and only by degrees spread into marine surroundings," and the first and larger of the two volumes now under review deals with the application of this view to the fishes. The volume, the preparation of which must clearly have involved a vast amount of research into the literature of the subject, makes out a strong case for the author's view, and in spite of its multiplicity of detail, provides interesting reading for any one interested in the evolutionary history of the lower vertebrates.

It is to be regretted that the author will be regarded by most vertebrate morphologists as having to a certain extent queered his pitch by his adhesion to certain theories now generally discarded. He is a firm believer that vertebrates are descended from nemerteans. The majority of morphologists are probably now in agreement that the various types of ancestral vertebrate above the cœlenterate level of organisation have continued on their evolutionary way and are no longer to be recognised as persisting in any of the invertebrate groups of to-day, whether Nemertea, Annelida, Arthropoda, or any other.

From his various references to the air-bladder, it would appear that the author regards this organ as being in the teleostean fishes respiratory in function, and that he believes that in marine fishes it tends to degenerate in correlation with the higher degree of oxygenation of the water making the gills more competent to deal with the respiratory needs. As a matter of fact, our present-day knowledge of the morphology and physiology of the air-bladder seems to establish clearly (1) that this organ of the teleost is an evolutionary development from the lung, (2) that its function is a hydrostatic one—serving to keep the specific gravity of the fish equal to that of the water in which it swims, regardless of changes of pressure due to changes of depth, and (3) that its disappearance in particular teleosts is, as a general rule, related to their having adopted a bottom-frequenting habit.

Passing over such points of detail, which after all are not essential to the main thesis, we find that the larger part of the book is devoted to a discussion of the physical and biological environment of fishes during the various geological periods (Chapters iv.-viii.), and to a survey of the distribution of the various groups of fishes in relation to time and space (Chapters ix.-xiii.). The chapters dealing with these subjects are preceded by three introductory chapters—the first more or less philosophical, the second dealing with geological conditions in relation to the evolution of fishes, and the third dealing with the evolution of fishes from the invertebrata. The closing chapters of the book deal with the distribution of fishes in relation to geological and geographical conditions in the past (Chapter xiv.), fishes in relation to a Southern continent (Chapter xv.), the problem of Lake Tanganyika (Chapter xvi.), and the geographical and geological relations of the more primitive fishes (Chapter xvii.).

As has already been indicated, the main sections of the book are palæontological, and these gain much in interest and value from the author's breadth of view. He appreciates the disintegrative effect of bacterial and other agencies, and sees that to explain the wonderfully complete and exquisitely preserved entire fish skeletons occurring in certain deposits, it is necessary to assume abnormal conditions such as showers of volcanic ash at the time of their entombment. He also would appear to appreciate—as so many palæontologists do not—the need of taking due account of everything available from the studies of embryologists and anatomists upon allied types of existing animals when endeavouring to draw general morphological conclusions from the facts of palæontology.

In his review of the successive geological formations, the author urges that the Downtonian and other Upper Silurian deposits, containing abundant remains of primitive fish, are undoubtedly of fresh-water origin. He accepts the generally admitted fresh-water character of the Old Red with its archaic types of elasmobranchs,

dipneusts, and ganoids. During the earlier part of the Carboniferous period the abundant fish population was still predominatingly fresh-water, although now for the first time seaward migration of various elasmobranchs foreshadowed the marine fish fauna of the Carboniferous Limestone. These marine fishes soon died out, and in Triassic times the predominatingly ganoid fish fauna became again restricted to fresh water. In Jurassic times, fish began again to spread into the sea—the immigrants this time including actinopterygian teleostomes as well as elasmobranchs. This invasion of the sea by elasmobranchs from fresh water became still more pronounced during the Cretaceous period, a number of genera becoming conspicuous that still persist at the present day, while they were now accompanied by typically teleostean derivatives of the Ganoidei. In the fresh waters were other teleostean types, ancestors of some of the great fresh-water groups of to-day, while with them were still abundant dipneusts and ganoids. Curiously, the Cretaceous teleosts all died out and became replaced by new Eocene types, although many of the elasmobranchs persisted unchanged.

(2) The second volume, like the first, is written to sustain a particular thesis, in this case more restricted in scope but at the same time of greater practical interest. While there is general agreement that mineral oil is of organic origin, there is no such general agreement as to the type of organisms to which the great oil deposits owe their origin, some assigning the chief rôle to vegetable organisms, others to Protozoa such as Foraminifera, others again to fish. Prof. Macfarlane is a strong supporter of the last-mentioned view, and in this volume he marshals the evidence in what will seem to many convincing fashion, in spite of his various heresies in regard to the evolution of the early vertebrates.

The author points out the frequent association in geological time of oil-containing deposits with rocks containing abundant remains of fresh-water fish. Although a botanist, he does not allow that vegetable remains have played any appreciable part in the production of oil. "The group of fishes alone in the animal kingdom conforms in every respect to the requirements for formation of crude petroleum." Their sudden destruction in immense shoals, their frequent richness in oil, their tendency to float and to accumulate in masses, and the rapid disengagement of oil from their decaying bodies, present a combination of factors favourable to the production of petroleum "not even approached distantly by any other group of animals." Kerogenite or oil-shale—the main source of crude petroleum—is invariably associated with fish remains, and in accounting for its formation the author recalls the experimental work of Stuart, showing how oil in muddy water tends to be carried down and entangled among the deposits of mud at the bottom.

Prof. Macfarlane recognises in the course of geologic history a number of distinct epochs during which oil formation was particularly active—an Old Red epoch synchronous with the abundance of fresh-water elasmobranchs, dipneusts, and other primitive fish during the Middle and Later Devonian period, a Jurassic epoch when the abundance of fresh-water ganoids reached its climax, a late Cretaceous and early Tertiary epoch marked by great abundance of marine elasmobranchs and still later epochs marked by oil-deposits of teleostean origin—first marine and later, as the present day is approached, fresh-water.

The author takes an optimistic view as to the oil supplies of the future. In addition to large, as yet untapped, supplies of free oil in various parts of the world, he emphasises the presence of vast expanses of oil-shale, both in the old and new worlds, which merely await the development of more efficient means of extraction. Holding the views he does, he very rightly insists upon the need of highly trained geologists, with special training in fish palæontology, for the working out of possible sources of oil-supply in the future.

Properties of Colloidal Systems.

Licht und Farbe in Kolloiden: eine phänomenologische Monographie. Von Prof. Dr. Wolfgang Ostwald. Erster Teil: Optische Heterogenität, Polarisation, Drehung, allgemeine Absorption, Heterogenitätsfarben, Brechung. (Die Ergebnisse bis 1914.) (Handbuch der Kolloidwissenschaft in Einzeldarstellungen, Band 1.) Pp. xiv + 556 + 17 Tafeln. (Dresden und Leipzig: Theodor Steinkopff, 1924.) 7.60 dollars.

THE large volume before us is the first part of a work designed to deal exclusively and exhaustively with the optical properties of disperse systems. Readers familiar with the existing text-books of colloid chemistry, in which a score of pages, or less, is devoted to these properties, will be struck with the large amount of information which the author has made readily accessible. The method of presentation he has chosen is, we are told, the "phenomenological," an adjective which the author feels obliged to explain even to the German reader; he does so in the following terms: "The author sees the characteristic of this method of presentation in the attention paid to *all* phenomena, and not only to selected ones, which fit a particular theory. A second characteristic consists in the attempt to separate concepts and to arrange phenomena in orderly fashion as neatly as possible." It will be

nerally agreed that these are desiderata in all scientific iting, but the author develops an antithesis between henomenological and mathematical treatment which ill scarcely command such general assent. Fortunately, the important question whether quantitative lations can be discovered, or be proved to hold generly, by methods other than mathematical, need not be bated here, as the vast majority of the phenomena eated in the work under review are much too comicated for mathematical treatment at present. Even here such treatment has been carried out, with all the paratus of modern mathematical physics, as in the se of gold sols, the results are only in moderate agreeent with experimental measurements.

The six headings of the sub-title give an indication the scope of the present volume. Optical heterogeneity and its most striking macroscopic manifestation, rbidity, are first discussed generally, and the contriutory factors; reflection, refraction and scattering the interface are analysed. The Tyndall phenomenon is then treated at great length; Rayleigh's rmula for non-conducting particles and Mie's for gold articles, both small compared with wave-length, are iven and calculated results are compared with exerimental determinations. A chapter on the design nd use of the ultra-microscope follows, which far xceeds in scope and completeness anything to be ound in the existing literature. It is illustrated with number of exceptionally beautiful plates, several of hem in colour, which will give the reader unfamiliar ith the instrument some idea of the appearance of ltra-microscopic images and, incidentally, of the ifficulty of interpreting most of them.

The chapter on polarisation falls into two main ivisions: the state of polarisation of the light reflected nd scattered by small particles, and the optical activity f certain sols. Among the most interesting phenonena described is the multirotation of gelatin, the hange of specific rotation with age being paralleled by change in viscosity. The connexion between the wo is obscure, and its elucidation might throw light n the constitution of emulsoid sols. The chapter on bsorption deals largely with the applicability of Lambert's and Beer's formulæ to disperse systems, and the effect of the degree of dispersity on selective absorption. Colours produced by optical heterogeneity form the subject of the next section; as one of the chief factors in producing colour in systems with *non*-metallic particles is the preferential scattering of the shorter wave-lengths, there is a certain amount of overlapping with the first section. In the final chapter the problem of a "mean" refractive index of heterogeneous systems and attempts to deduce it from the constants and the volume ratios of the phases are treated.

The author confesses to a special affection for his present subject, and his enjoyment in developing it is, indeed, quite obvious. While such enjoyment on the author's part is certainly stimulating to the reader, it has led to a breadth of treatment which (as the preface admits) may sometimes seem excessive, and to a certain amount of repetition. The latter may not be a defect to the student, who will not read the book at one sitting nor probably "with his feet on the fender." The author naturally has to deal with a number of controversial subjects—the interpretation of the microscopic and ultra-microscopic images of gels is a good example—and, while he does so with plenty of spirit, he manages to write entirely *sine ira et studio*.

The book, as stated on the title page, covers the literature up to 1914. Even during the comparatively sterile period of the last ten years some investigations of fundamental importance have appeared, *e.g.*, to mention one only, that by Porter and Keene on sulphur suspensions containing particles *large compared with wave-lengths* and indigo in *transmitted* light. No theory of this phenomenon is available so far; until one is found there will be a distinct gap in the optics of disperse systems.

This and a few other omissions caused by the avowed limitation to work done before 1914 do not in any way detract from the value of the book. It provides a very large amount of information, little of which is to be found in the existing text-books, on some of the most immediately striking, and at the same time important, properties of colloidal systems. The purchaser will have to let this consideration weigh against the price, which, like that of many recent German books, is very high—although no doubt the lavish and expensive illustrations go some way towards justifying it.

E. H.

The Appeal of the Himalaya.

Wonders of the Himalaya. By Sir Francis Younghusband. Pp. vii+210. (London: John Murray, 1924.) 10*s.* 6*d.* net.

SIR FRANCIS YOUNGHUSBAND is one of the great Asiatic explorers, for he was almost the first to cross Central Asia from Pekin to India, the first to traverse the Mustagh and other high passes in the north-western Himalaya, and was in later years head of the British expedition to Lhasa. The effect of his new book should be to inspire many of the coming generation with his passion for exploration, and especially for investigation of the unsolved problems of the Himalaya. The volume is a popular narrative of four of his early journeys, made when he was a

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subaltern in the King's Dragoon Guards. Life in that regiment did not satisfy him.

"I would gladly," he says, "have entered into the life of a cavalry regiment if the regiment had been really in earnest about training itself for war. But they were not. The Colonel had had me up in orderly room and told me that I was always going on as if we were preparing for active service; but we never went on active service, so it was of no use preparing for it. What we had to do was to prepare to turn out smart for parade when some general came round, and in that way we should get a good name."

Lieut. Younghusband came of a family of explorers. He was a nephew of Shaw of Yarkand, and a regiment governed by a man who would have been appropriately its head tailor gave inadequate scope for his energies. He soon made his name as a most capable explorer and was sent on various missions, his success in which gained for him, by the age of twenty-four, the Gold Medal of the Royal Geographical Society. The author expresses the hope that his book will be read by boys; but it would appeal to readers of almost any age, owing to its expression of the author's deep enjoyment of his experiences, his appreciation of the good qualities of his men, and its graphic descriptions of Himalayan geography. The expeditions described include his preparatory traverse in the southern Himalaya through Dharmsala to Simla; to Manchuria in 1886; across Central Asia from Pekin to Rawal Pindi, during which he passed through the Karakorams and over the Mustagh Pass; and a special mission in northern Kashmir to search for the supposed Saltoro Pass, to investigate the depredations by Hunza raiders in the Pamir and Hunza country, and to note the proceedings of a Russian expedition that was secretly visiting that region.

Sir Francis Younghusband is a dauntless traveller, and his courage is displayed by his defiance of those who regard beginning a sentence with a preposition as one of the worst of literary sins. He does it habitually—half-a-dozen times on a page, and with two succeeding sentences beginning with "but."

The narratives are throughout of intense interest, and may be read with pleasure by those who know the previously published accounts of the expeditions, for amid the stories of narrow escapes from avalanche or suspicious Asiatics are pæans on the Himalaya and their wonders and majesty. Sir Francis Younghusband describes their barrenness, poverty, and intertribal strife; but he makes his reader share his feeling that these ills are evanescent, and that the grandeur, purity, and light of snow-capped mountains are the source of their never-tiring joy and inspiration.

J. W. G.

Mathematics for Engineers.

(1) *The Design of Diagrams for Engineering Formul and the Theory of Nomography.* By Dr. Lauren I. Hewes and Herbert L. Seward. Pp. xiii + 11 (London: McGraw-Hill Publishing Co., Ltd., 1923 25*s*.

(2) *Elements of Graphic Statics.* By Prof. Clarenc W. Hudson and Prof. Edward J. Squire. Pp. viii + 9 (London: McGraw-Hill Publishing Co., Ltd., 1923 6*s*. 3*d*.

(3) *A Treatise on Engine Balance using Exponential* By P. Cormac. Pp. xi + 151. (London: Chapma and Hall, Ltd., 1923.) 21*s*. net.

(4) *Leçons de mécanique rationnelle, professées à l'Éco des Mines et de Métallurgie Faculté technique d Hainaut à Mons.* Par François Bouny. Tome 1 Calcul vectoriel, Cinématique, Statique, Potentie Pp. viii + 600. (Paris: Albert Blanchard; Mons Librairie Leich, 1924.) 50 francs.

(1) MESSRS. Hewes and Seward's account o chart construction for engineering formul consists of two main sections. The first 34 page are somewhat general in character, and explain th formation of functional scales and the drawing o charts in general. The remaining 70 pages are devote to the theory and practice of nomography. Bot portions are well written, with a wealth of excellen diagrammatic illustration. The book is well printe and the charts well reproduced.

The volume is obviously intended for readers wh are not shy of mathematical reasoning and calculation This is illustrated by the beginning of Chapter iii. where the nomography proper commences. The authors base themselves on the fundamental property of collinear points, namely, that their Cartesian co-ordinates satisfy a determinantal equation, and they show how various types of problems can be solved nomographically. If it can be assumed that engineers can follow such reasoning with ease, then there is something to be said in favour of this mode of presentation; and the authors do it fairly well. We must point out, however, that it is fatal to become a slave to one particular line of reasoning or to one particular method. To do all formulæ by the determinantal method is dull and by no means educative, while often this method is distinctly more laborious than straightforward practical processes which can be readily devised in most cases from easy first principles. Probably most engineers would prefer elegance and ease of design to logical completeness of mathematical argument.

(2) In their little book on graphic statics, Profs. Hudson and Squire give a careful study of the

theory of forces in a plane, and then apply the methods to simple structures, and to the discussion of shearing forces and bending moments. The book is pleasant to read, never irrelevant and always to the point. Fig. 9a is upside down!

(3) The first few pages of Mr. Cormac's book tend to discourage the prospective reader. One does not like such disregard of usual practice as $a \times -1 \times -1 = a$. One cannot approve of the statement that $dz/d\theta = \iota z$ gives $z = e^{\iota\theta} + C$, so that if $z = 1$ when $\theta = 0$, we get $C = 0$. It is unpleasant to see $\lfloor 3$ written $\lfloor_3$. It is unusual to write $(1 + 2h \cos\theta + h^2)$ with (1 on one line and the remainder in the next. But all this only means that Mr. Cormac should have submitted his manuscript or the proofs to a severer scrutiny: it does not destroy the interest and value of the attempt made by the author to develop the theory of engine balance by means of exponentials, or more correctly by the use of vectors in the Argand plane. The idea is that a mass m at distance r from an axis of rotation ω, in direction θ measured from a fixed direction, has acceleration representable by $-r\omega^2 e^{\iota\theta}$ and an "inertia resistance" representable by $mr\omega^2 e^{\iota\theta}$. In conjunction with various expansions like $(1 - r\cos\theta)/(1 - 2r\cos\theta + r^2)$ in terms of Fourier series, elaborately worked out in an appendix of 20 pages, this notation is applied to various types of engines, flywheels, and cranks. The book is an interesting application of complex numbers and de Moivre's theorem to an important topic in engineering practice, and is on the whole well written.

(4) Prof. Bouny's book is the first part of a treatise on the principles of mechanics intended for students of technology. The present volume discusses vectors, kinematics, and statics (including potential theory). Volume II. will deal with particle and rigid dynamics and with the mechanics of continua. It is stated that the book represents lectures delivered to first and second year students at the School of Mining and Metallurgy at Mons, the students being in general beginners in the study of theoretical mechanics.

As is to be expected, the book is very reminiscent of French treatises, both in matter and in method. It is in fact a treatise in the real sense of the word, the subject being discussed with the logical completeness and the logical sequence that form so admirable a feature of French school and university text-books. In Great Britain, text-books are written with the object of coaxing the student, especially if he happens to be studying technology, so that he is suspected of taking but little interest in theoretical and fundamental principles. French and Belgian writers do not coax their readers. They explain their subject carefully, logically, and with full-dress seriousness. Examples, if they exist at all, do not pander to the tastes of engineers who like to see practical applications with numerical results!

The present volume is in fact one that anybody may read who wishes to study the principles of mechanics for their own sake, and not merely if he happens to be interested in mines but is yet prepared to admit that theoretical principles also deserve attention. The standard is somewhat high. Only the best equipped mathematicians among technological students at British universities could read with profit Prof. Bouny's book. Mathematicians should certainly read it. There are nearly 300 examples with solutions.

Vectorial notation and methods are used throughout. For the mining engineer and metallurgist this must be a distinct hardship, because the kind of mechanics they need is such that the use of vectors would be sheer faddism. This is tacitly admitted by the author himself, who gives the most important results in ordinary Cartesian, polar, or intrinsic notation as the case may require for practical application, after having deduced the vectorial forms. S. BRODETSKY.

Practical Human Physiology.

Human Physiology: a Practical Course. By C. G. Douglas and J. G. Priestley. Pp. ix + 232. (Oxford: At the Clarendon Press; London: Oxford University Press, 1924.) 12*s.* 6*d.* net.

DURING the last twenty or thirty years, with the vast increase in physiological knowledge, especially from animal experiments and from the chemical point of view, there has been unfortunately an increasing divorce between medicine and physiology to the detriment of both. The researches of Haldane and his fellow-workers on respiration have been mainly human experiments, and probably most of his results could not have been carried out in any other way. This is the point of view of the book before us, and the experiments given can all be performed on the students themselves. It is based on the practical course for the honour school of physiology at Oxford, and taken with Sir Charles Sherrington's book on "Mammalian Physiology" the ground is covered very thoroughly. Naturally, a large proportion of the book is devoted to respiration—nearly three-quarters, using respiration in its widest sense of the transport of oxygen and carbon dioxide by the blood as well as through the lungs. This section includes such important subjects as the effects of muscular work and the administration of oxygen, the determination of the basal metabolism, of the volume and reaction of the blood as well as the more usual determination of oxygen and carbon dioxide carrying capacity. The book does not,

however, deal with respiration alone. Modern methods of blood examination are discussed, including the agglutination of the red cells, blood grouping, transfusion and the fragility of the red cells. The functions of the kidney are investigated, water diuresis is discussed, and methods given for the determination of the sugar and urea in the blood. The recent important work of J. B. S. Haldane on the maximum concentration of chloride and bicarbonate in the urine is very suitable for class work and is included.

Under the heart and circulatory system, blood pressure and the polygraph tracings of the pulse are investigated experimentally, and the electro-cardiograph is shortly referred to. Finally, there is an excellent section on the investigation of the stomach and intestine by X-rays and the stomach tube. Contrary to general impressions, these facts are very suitable for class experiments, and easily rouse interest and give valuable results.

A practical course serves two main purposes — to demonstrate the general truth of the science and to train the student in methods of investigation. For the man who devotes his life to physiology, all methods are almost equally important, and animal experiments here may have advantages over experiments on man, as well as some disadvantages. Most students of physiology intend to practise medicine, and here perforce the subject of experiment is generally human, whether in the great experiment designed by Nature such as disease, or in careful observation of treatment. It is in this way that the present book is particularly valuable.

In one other way the volume is admirable. Many practical books consist of a list of unconnected experiments, and the book is of little use outside the laboratory. This book is eminently readable, and the experiments are put together as a connected whole, although complete details are given for the actual experiments and for the calculation of the results—an important thing in any respiration work.

The only serious drawbacks are the large branches of physiology which are left untouched—the central nervous system and metabolism as studied by changes in the urine with work, rest, and various diets. Perhaps the authors are right in leaving this to be written by some one else, and keeping themselves to the branches in which they have such unrivalled practical experience.

The course is more suitable for small advanced classes. Perhaps in a few years, when other courses similar to this and covering the other branches of physiology have been written, it will be possible to abstract a shorter and simpler practical course of human physiology which should be followed by all students of medicine.

Our Bookshelf.

Birds in their Relations to Man: a Manual of Economic Ornithology for the United States and Canada. By Dr. Clarence M. Weed and Dr. Ned Dearborn. Third edition, revised. Pp. viii+414+18 plates. (Philadelphia and London: J. B. Lippincott Co., 1924.) 15*s.* net.

As this book deals with North American birds and conditions, its interest to readers in Great Britain is naturally general rather than particular. Nearly half the space is allotted to a detailed consideration of the food habits of the species which are of most importance economically in the United States: in addition, however, there are chapters on methods for studying the food of birds, on the development of economic ornithology in America, on birds' food in general, and on measures for the conservation and encouragement of useful species and for preventing the depredations of those which are injurious.

From among the many examples to be found in the book, the following evidence as to the economic value of birds may be cited. During a plague of canker-worms in Illinois orchards, the stomach contents of 141 birds belonging to 36 species were examined. Canker-worms were found in 60 per cent. of the individuals and 72 per cent. of the species, and formed 35 per cent. of the total food of all the birds examined. It may be noted also that, so long ago as 1885, economic ornithology was taken up by the Federal Government, and the task of investigation and public instruction entrusted to what is now the Bureau of Biological Survey of the U.S. Department of Agriculture.

A summary is given of the State and Federal (but not Canadian) laws for the protection of birds, and the underlying principles of these are of some interest. The State laws, varying in detail from one State to another, are of primary importance and are based on the assumption that all game and wild birds are the property of the State, and may only be killed as the State Government may permit: landowners have no privileged position in this respect. The Federal law before 1913 merely reinforced the local laws in incidental ways, but it was then decreed that birds which do not permanently remain within a given State are the property of the United States Government, and so certain migratory species are now protected by a Federal Act. The authors fail to carry this development a stage further and to mention the Migratory Birds Convention of 1917, which provided for reciprocal legislation in Canada and the United States. One also notes that the bibliography contains no reference of later date than 1915.

Précis de chimie physique. Par H. Vigneron. Pp. xii+408. (Paris: Masson et Cie, 1924.) 30 francs.

M. VIGNERON'S book deals with general theories rather than with details of experimental methods, and he is therefore able to cover a wide range of topics in a somewhat small space. He points out that a large part of the subject can be discussed adequately from the kinetic point of view by means of molecular models; but that after a certain point has been passed, these have to be elaborated more and more, until they become of no real value in the quantitative interpretation

the phenomena. It is at this point that thermodynamical relations become important, since the mechanism of the processes can then be neglected; but with the obvious drawback that these relations throw very little light on the mechanism, and are therefore more satisfying to the physicist than to the chemist.

It is, indeed, not unusual in France for physical chemistry to be studied and taught by a physicist, instead of by chemists only, and this difference may account for a rather refreshing variation in the author's method of treatment; but this is counterbalanced by his complete lack of interest in the chemical characteristics of the materials studied. Thus all his phase-rule diagrams are anonymous, and in this way lose the interest that comes from studying facts instead of theories; and he attributed to cyanobenzene, "another organic compound," as he explains to his readers, an unsymmetric quality which this simple and symmetrical substance could not possibly possess, and was actually detected in the case of amyl *p*-cyanobenzylideneaminocinnamate. Such an error would be impossible in the case of a chemist with even a modest knowledge of organic chemistry.

This view of the author's own limitations is confirmed by the fact that the chapter on physical properties and chemical constitution contains no reference to optical activity, by his classification of the fats as "glucosides" of the fatty acids, and by his statement that oleic can be converted into stearic acid by "adding to its molecule an atom of hydrogen." The book may, however, be heartily commended to chemical students who have already mastered this side of their subject, since they can be quite sure that there will be no duplication, and that they will find the author's method of treatment both novel and stimulating.

Chemistry for Dental Students. By Prof. H. Carlton Smith and Rachel M. Smith. Fourth edition, revised and enlarged. Vol. 1: *Qualitative Analysis and Dental Metallurgy.* Pp. vii+186. 12*s.* 6*d.* net. Vol. 2: *Organic and Physiological Dental Chemistry.* Pp. v+320. 17*s.* 6*d.* net. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.)

THESE volumes, comprising the fourth edition, are intended to provide for courses in chemistry, dental metallurgy, dental materia medica and physiological chemistry for dental students, and have been written primarily to meet the requirements of American students. Nevertheless the methods adopted are sufficiently general to appeal to wider interests. The sections on microchemical analysis and physiological chemistry are to be noted specially, particularly Chap. xviii. on saliva. The subject matter for these sections has been selected with special reference to dental problems, and is quite likely, from the method adopted, to stimulate a desire on the part of the student to learn more of the subject generally. The chapter on tooth decay, being a readable summary of the present state of knowledge of the subject, may be recommended to others besides dental students.

The plates are good and give an adequate idea of the appearance of the substances as seen in the microscope. References are given to original work and to special text-books, mostly to American works. It would be an advantage to British students if references to corresponding British text-books and original work were furnished.

The authors' intention appears to be to induce students to continue their study of dental chemistry, and in this they may fairly claim to have been successful.

J. J. F.

Collective Index of the Journal of the Institute of Brewing, 1911 to 1923. Compiled by W. H. Bird. Pp. iv+330. (London: Harrison and Sons, Ltd., 1924.) n.p.

THE production of indexes is a laborious and often a thankless task, yet to their compilers the scientific world owes a deep debt of gratitude. The work before us is carried out consistently upon a recognised principle, and is presented in a clear and workmanlike manner. In adopting the principle of the "Inverted Title" as the basis for the construction of his Index of Subjects, Mr. Bird is probably following the style of an earlier index to the Journal of the Institute. Our criticism, at any rate, is directed to show the defects of indexes prepared on this principle. Such indexes are, of course, in reality "Title Indexes"; they serve as subject indexes only by the accident of the language of their titles. As the following illustration will show, such indexes are cumbersome, owing to the repetition of the titles, inconvenient for study, and costly to produce. For example, "Cold: beer towards—, and the Wallerstein process; sensitiveness of. P. Petit. 1916. 468." This entry, suitably modified, appears four times in the Index—occupying eight lines. In the modern type of index one entry would suffice, with a reference from the Wallerstein Process. Moreover, the modern index would bring together matter which in the above Index is distributed under "Chilling," "Cooling," "Refrigeration," "Temperature," etc. The "Inverted Title" index still survives in the book trade, but it has long been discarded from library practice. It is, in our opinion, wholly unsuited for the purposes of Collective Indexes to the papers of learned societies.

E. W. H.

Infection and Resistance: an Exposition of the Biological Phenomena underlying the Occurrence of Infection and the Recovery of the Animal Body from Infectious Disease; with a Consideration of the Principles underlying Specific Diagnosis and Therapeutic Measures. By Prof. Hans Zinsser. Third edition. Pp. xvi+666. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923). 24*s.* net.

PERHAPS no medical or biological subject has expanded to such an extent as that of immunity, when one remembers that its origin dates back only to the late 'eighties of last century. Its doctrines have, however, revolutionised the medical outlook on the questions of infection and resistance and are now bearing practical fruit in the prophylaxis and treatment of infective disease. It is scarcely possible for one man unaided to deal adequately with the whole subject. All that he can do is by extensive and intensive study to give a critical estimate of the general trend and scope of the subject. This, Dr.

Hans Zinsser, professor of bacteriology and immunity at Harvard, has attempted to do, and, in our judgment, with a great measure of success. We have carefully read through his book and can strongly recommend it as an authoritative work. On every page are the signs of extensive acquaintance with the literature, and from all the wealth of details and contradictions of the latter, he has succeeded in creating a readable account of what must prove a fascinating subject of study to all. W. B.

Continuous Current Circuits and Machinery. By Prof. J. H. Morecroft and Prof. F. W. Hehre. Vol. 1. Pp. viii+467. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 20*s*. net.

THIS book is designed primarily for the use of students in engineering schools. An elementary knowledge of physics and mathematics is all that is demanded of the reader, and yet a good introduction is given to practical engineering calculations and methods. The authors begin by a brief description of the electron theory, as many of the phenomena described follow readily when this theory is adopted. Some of the sentences, however, may well puzzle the beginner. "This shortage of electrons at the end of the rod constitutes the positive charge at this end." The positive charge, therefore, seems to have no real existence. Similarly we are told that a negative charge can exist in a perfect vacuum. It, also, can have little real existence. This is better, however, than talking about positive and negative fluids.

Following a prevalent practice among engineers, the authors seem to make little distinction between magnetic induction and magnetic force. A *gauss* is defined as a *maxwell* per square centimetre. It is better to define the maxwell as the unit line or tube of magnetic induction and not as a line of force. Many useful examples in electrical engineering are given, and the student who works through them all will have made good progress in becoming a qualified electrical engineer. We regard this as a book suitable for first and second year students at a technical college and can recommend it as such.

A Bibliography of Sir Thomas Browne, Kt., M.D. By Geoffrey Keynes. Pp. xii+255+5 plates. (Cambridge: At the University Press, 1924.) 42*s*. net.

THIS handsome volume, of which only five hundred copies have been issued, is dedicated to the memory of Sir William Osler, who was one of the most enthusiastic admirers of Sir Thomas Browne. The work consists of twelve sections, the first ten of which are devoted to the bibliography of Sir Thomas Browne's writings, and the last two to the bibliography of biography and criticism and the sale catalogue of Sir Thomas Browne's library, all but two of the sections being preceded by a bibliographical preface. There are four appendices containing the bibliographies of imitators of "Religio Medici" and "Vulgar Errors," and of the works of Dr. Edward Browne, Sir Thomas's eldest son, and an account of Simon Wilkin, the Norwich publisher and editor of Sir Thomas Browne's works. The text is interspersed with reproductions of the MS. and title pages of early copies of "Religio Medici," "Hydrotaphia," "Christian Morals," and other works. There are two fine portraits, the first, which serves as a frontispiece, being that of Sir Thomas and his wife, Dame Dorothy Browne, by an unknown artist, and the other that of Simon Wilkin.

Mr. Geoffrey Keynes, who is attached to the surgical unit of St. Bartholomew's Hospital, is to be congratulated on his scholarly achievement, on which, as we learn from the preface, he has been engaged for sixteen years. It will rank next to Wilkin's classical edition as the most important contribution to the literature of Sir Thomas Browne's works.

History of the Great War: Based on Official Documents. Medical Services General History. Vol. 4: *Medical Services during the Operations on the Gallipoli Peninsula; in Macedonia; in Mesopotamia and North-West Persia; in East Africa; in the Aden Protectorate, and in North Russia. Ambulance Transport during the War.* By Maj.-Gen. Sir W. G. Macpherson and Maj. T. J. Mitchell. Pp. xvi+711. (London: H.M. Stationery Office, 1924.) 25*s*. net.

THIS is the final volume of the general history of the Medical Services during the War, and is perhaps the most readable. The ground covered is adequately expressed in the title. The book shows the great and varied difficulties which had to be contended with, and while it is clear that towards the end of the campaigns the problems were mastered to a certain extent, there were deplorable breakdowns in the Dardanelles, Mesopotamia, and East Africa, some being so notorious as to lead to Parliamentary inquiries. These disasters are attributed mostly to lack of preparation before the campaigns started, but the editors, naturally perhaps, do not commit themselves to an exact statement as to the rank and position of those actually concerned. They admit, however, that "in some respects the administration of the Medical Services was a factor in the breakdowns."

Introduction to Modern Philosophy. By C. E. M. Joad. (The World's Manuals.) Pp. 112+4 plates. (London: Oxford University Press, 1924.) 2*s*. 6*d*. net.

MR. JOAD'S little volume is clearly written and gives a short outline of the present tendencies in modern philosophic thought. It contains chapters on the difference between idealism and realism, Mr. Bertrand Russell, Croce and Gentile, pragmatism, and finally Bergson. At the end of each chapter is a criticism of each system. The work is rather too short to be of much use to scholars, but it ought to fulfil admirably the purpose for which it is written, namely, to present to non-professional readers the works of the professional writers.

Physikalische Chemie der Zelle und der Gewebe. Von Prof. Dr. Rudolf Höber. Fünfte, neubearbeitete Auflage. Hälfte 2. Pp. v+545-906+xi-xvi. (Leipzig: Wilhelm Engelmann, 1924.) 12 gold marks.

THE second half of this volume, of which the preceding part was noticed in these columns on July 21, 1923 (vol. 112, p. 93), has been received. It contains the remaining Chapters viii. to xii. of the new edition.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Wind and Waves.

In a letter published in NATURE on August 19, 1920, p. 777, I said that, judging from appearances, wind-formed waves increased in length only when the waves were in a "breaking" condition, and it was suggested that the breaking crests, by imparting their momentum to the upper strata of the water, and so establishing a gradually increasing surface current, would necessarily also cause a gradual increase in the wave-length equal to the increase of stream speed per wave-length × by the period of the wave. An example of the alteration in the lengths of a train of breaking waves may be seen at the foot of any weir where the flow is sufficient to form a stationary "bore." The wave where the stream over the apron is first arrested carries a large breaking crest, and down-stream follow several waves also breaking, but not so heavily. Following these again are waves which do not break, and counting from the first wave, observation will show that the distance from crest to crest diminishes notably so long as the waves are breaking.

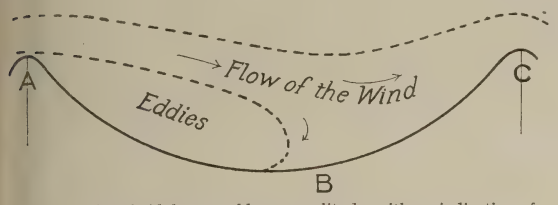

FIG. 1.—Trochoidal wave of large amplitude, with an indication of the direction of the flow of the wind.

The cause indicated in my earlier letter must certainly have some effect, but it seems inadequate to account for the long waves met with in the ocean. Another way in which the action of the wind may increase the wave-length is that when the wave slopes are steep, each crest acts as a screen to the water surface immediately to leeward, and the full force of the wind operates only on the windward slopes, while the trough and lee surfaces are more or less becalmed (Fig. 1). The results of this irregular distribution of wind pressure are considered briefly in the present note.

There have been no accurate observations of the shapes of wind-formed waves—not sufficiently accurate, that is, to distinguish them either from the trochoidal waves of Rankin and Froude or irrotational gravity waves, which have been only partially investigated. So long as the amplitude is small all these forms should be nearly identical, but the limiting form for the trochoidal wave is a cycloid, the crest of which is a knife edge with an angle of 0°, while for the irrotational wave the limiting crest angle (according to Stokes) is 120°.

The other chief difference between these forms is that while in the trochoidal wave each particle moves in a circular orbit, and returns to exactly the same position after each wave period, in the irrotational wave there is a continuous forward motion of the fluid, greatest at the surface and rapidly decreasing with the depth, but always small compared with the wave speed. Thus, in the irrotational wave, the orbits of the particles are not closed curves but form a succession of loops.

It will be sufficient for the present purpose to consider only trochoidal waves, and in Figs. 2 and 3 the principal properties of such waves are shown diagrammatically.

Fig. 2 gives the wave-length and wave velocity in terms of the wave period. These quantities can be easily determined from the limiting cycloidal form, for at the crest in this case the weight of the particle is just balanced by the centrifugal force in the orbit, and the particle in the crest moves with the same velocity and in the same direction as the wave, so that $4\pi^2 a/T^2 = g$, $v = 2\pi a/T$, and $\lambda = gT^2 2\pi$, where a is the radius of the generating circle of the cycloid, v the wave velocity, and λ the length of a wave the period of which is T.

It is easy and convenient to remember that a wave the period of which is 1 second is nearly 5 ft. long, and that a 6-second wave is nearly 180 ft. long and has a speed of 18 knots.

Below the surface the amplitude of the wave motion decreases exponentially with the depth, and if r is the amplitude at depth D, $r = ae^{-\kappa D}$. The constant κ can be determined by the consideration that if in still water a certain portion is bounded by two level surfaces, that portion must retain the same volume when the level surfaces are transformed into equipotential trochoidal surfaces by the wave motion. From this it is found that $\kappa = 1/a$, so that for every

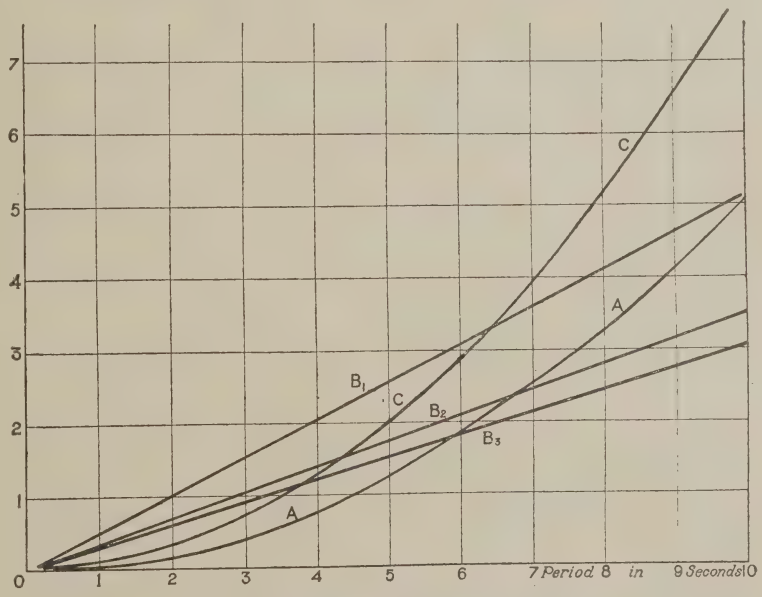

FIG. 2.—Relation between the periods, wave-length, and velocity of trochoidal waves.
Ordinates of A × 10² = wave-length in ft.
" $B_1 \times 10$ = velocity in ft. per sec.
" $B_2 \times 10$ = " miles per hour.
" $B_3 \times 10$ = " knots.
" C × 10 = amplitude of corresponding cycloid, in feet.

trochoidal wave the amplitude is reduced to $1/e$ of the surface value at a depth equal to the radius of the generating circle of the corresponding cycloid.

The reduction of amplitude is shown to scale in Fig. 3. It is worth notice that the still-water level of the sea does not coincide with that of the centre of the generating circle of the trochoidal surface, the

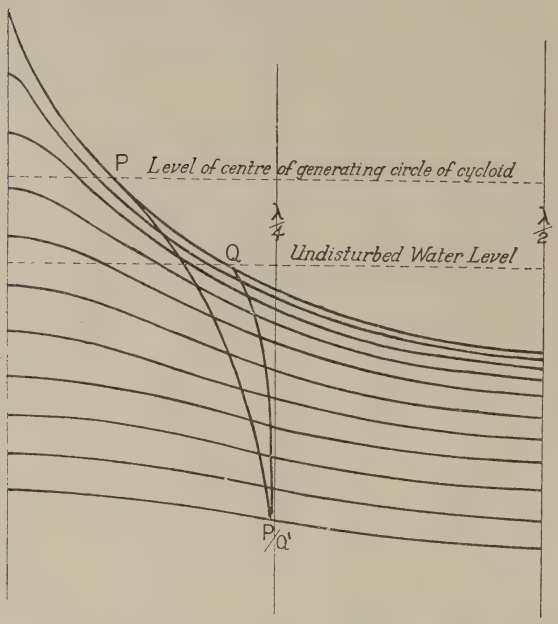

FIG. 3.—Equipotential surfaces showing the reduction of amplitude of the wave motion at different depths below the surface. The upper curve is a cycloid. For each succeeding curve the centre of the generating circle is lowered by $\frac{1}{4}$ of the radius of the generating circle of the cycloid. The intersections of the curve PP with the equipotential surfaces are the levels of the centres of the respective generating circles, and the intersections of QQ′ with the same are the still-water levels corresponding to each.

level in question being determined by the equality of the volumes of the raised and depressed parts of the fluid. This requires the equality of the shaded areas in Fig. 4. The intersections of the curve QQ′ in Fig. 3 with the equipotential surfaces give the still-water level of each, the intersections of PP being at the level of the centres of the generating circles. What the maximum height from trough to crest in

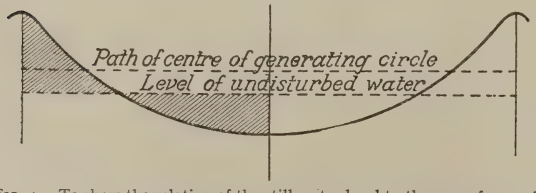

FIG. 4.—To show the relation of the still-water level to the wave form. The water raised and depressed above and below this level must have the same volume, which implies the equality of the shaded areas in the diagram.

ocean waves may be has never been accurately measured. This could be readily determined by photography in the following way: Let two cameras be fixed back to back with the axes of their lenses in the same line, and let a pair of such double cameras be used at different levels on board ship, simultaneous exposures being made with the cameras pointing in approximately the same direction. The four pictures thus obtained from each exposure would then give the data necessary for determining the height and length of the waves. Breaking waves more tha 600 ft. from crest to crest have been encountered, an had their form approached a cycloid, the height woul have been of the order of 200 ft. The most trust worthy guesses, however, do not, I believe, exceed quarter of this amount or less, and this is evidenc so far as it goes, that long waves of large amplitud depart from the trochoidal type, at any rate near th crests, although in other parts the difference i probably small.

Experience shows that these slopes are often stee enough to produce something like a calm in the lee o the crests, and to get an idea of the effect of the win on the wave in these conditions, it may be assume that, except near the crest, the motion is trochoida and that from A to B in Fig. 1 the atmospheri pressure on the surface is the same as if the wate was still, while from B to C it is increased by som fraction θ. In this part of the wave the orbits o the particles are convex to the direction of the wind and the excess of wind pressure, though not affectin the velocity of the particles, is equivalent to a reduc tion of the centrifugal force by an amount proportiona to that excess. From these two conditions, namely constancy of the particle velocity and reduction o centrifugal force, it will be found that for a reductio in the latter by some fraction θ, the radius of th orbit and the period are both increased by the same fraction, so that the original radius r and period T become, between B and C, $r(1+\theta)$ and $T(1+\theta)$, and in every complete period this growth would be repeated. Thus each wave formed by the wind may be considered as having different periods in different parts of its length, but the average length will continually increase. As stated above, the pressure of the wind has no effect on the orbital velocity of the particles, but the surface drag, acting only or chiefly on the windward slopes, will increase that velocity, and therefore also the amplitude.

Until experiments have been made on the action of wind on water, it seems scarcely worth while to attempt a quantitative estimate of the rate at which waves increase either in length or amplitude. It is obvious, however, that the rate is slow, for long waves are only formed on large water surfaces and after a considerable time. Experiments on the distribution of pressure on wave forms might be easily tried on solid models in any wind channel, but for the experimental production of wind-waves a rather more elaborate equipment would be required. The cost of this need not be large if any of the copies of Froude's experimental tank could be made available. Let a rectangular chamber, consisting of roof and sides only, say 3×6 ft. in section and some hundred feet long, be suspended in the tank, so that 3 ft. of the sides are immersed and a 3 ft. square channel left over the water surface; air currents of known velocity could be sent through this and the waves formed examined through suitable glass panels in the sides.

If the channel were 300 ft. in length, waves near the exit might probably reach a length of 2 feet, but a reference to Fig. 3 will show that the amplitude of the motion 3 ft. below the surface would be very small, so that the wave motion in the channel would have but little effect on the rest of the water in the tank. An efficient wave absorber (not merely a shelving beach) would be required to deal with the emergent waves. Experiments on the lines indicated above would, I believe, give valuable results not only as regards the generation of waves, but also as to the effect of wind in promoting ocean currents.

A. MALLOCK.

9 Baring Crescent, Exeter,
September 25.

The *St. George* Expedition to the Pacific.

WITH reference to recent newspaper notices of the ork being done by the scientific staff of the *St. George* xpedition to the Pacific, the members of the Scientific xpeditionary Research Association will be greatly bliged if you will give the courtesy of your columns the following brief résumé of the results obtained date.

The expedition reached the Isthmus of Panama on ne 9, 1924. After a short stay in the Canal Zone, evoted by the staff to assiduous collecting, the *t. George* carried out a lengthy cruise to the various opical islands of the Eastern Pacific, including the earl Islands in the Gulf of Panama, Gorgona, off olombia, and the Galapagos; Cocos, Coiba, and aboga islands were also visited. Very large zoo- gical collections were made at these islands, and is likely that a considerable number of new species nd varieties have been obtained. Small mammals ave been captured by Mr. P. H. Johnson at all the lands; these should prove of notable interest, as ew specimens have been obtained there previous to ur visit. They include numerous rats exhibiting a ide range of variation, particularly in the Galapagos.

Much attention has been given to the birds by ieut.-Col. Kelsall; up to the present more than 300 pecimens have been obtained, a number smaller than xpected, due to the difficult but unavoidable con- itions that often prevailed.

The entomologists have had conspicuous success, heir collections being most extensive. Miss Chees- man's attention has been devoted in the main to hose groups not usually collected, and which in onsequence are required to fill gaps in the British Museum collections. It is probable that some of he species will prove to be new, but it is impossible o ascertain this until they have been worked through y specialists. Lepidoptera and Coleoptera, collected y Mr. C. L. Collenette with the assistance of Miss ongfield, are very well represented; special attention vas devoted to the less conspicuous forms as being ikely to be of greater interest than the large and howy ones. Early stages have been described and reserved wherever possible; many ecological facts ave been recorded and should prove of great interest.

Dr. C. Crossland has made large collections of Polychæta, Nudibranchs, and Polyzoa, and Mr. J. Hornell, extensive series of Mollusca, marine and errestrial. It is expected that these will afford nost useful data for the settlement of synonymy nd consequently for better knowledge of geographical listribution. At least five Atlantic species of poly- chætes have been found in the Panama region, indicating that an appreciable number will be found common to the Atlantic and the Pacific when the collections are systematically examined.

Large numbers of flowering plants were gathered in the principal islands visited; those from Gorgona have been received at home already. We understand from a cable received a few days ago that the authorities at Kew place considerable value upon them; indeed, in consequence of their representations it has been decided to pay a second visit to this interesting island, in order to make the botanical material as complete as possible.

Geology has had adequate attention from Mr. L. J. Chubb, who has amassed an extensive series of notes and rock specimens from the various islands.

The outstanding result of the expedition, so far as can be judged at present, has been the discovery by the undersigned of several series of figures graven upon large boulders lying between tide-marks on the eastern shore of Gorgona. The most numerous were two series of archaic figures among which are distinguished what seem to be rude representations of sun-gods and a stepped pyramid, together with figures of monkeys, birds, and other animals. Besides these are two comparatively modern sculptured portraits, one perhaps of Incan age, the other referable to the buccaneering days of the eighteenth century.

A number of stone weapons and implements were also found, associated with potsherds of considerable interest. Advantage is to be taken of our pending return visit to search the island thoroughly for further archæological remains.

JAMES HORNELL,
Scientific Director, *St. George* Expedition.

Panama, September 24.

Optical Records and Relativity.

PROF. LLOYD MORGAN, in his interesting and most original and suggestive article, "Optical Records and Relativity" (NATURE, October 18, p. 577), sums up his argument in sixteen questions. These raise a variety of problems, but are all directed to the conclusion that we may accept the physics of relativity and yet find that the scientific creed of classical mechanics stands in no need of revision. The crux of his whole position appears to me to lie in the answer to his question 6, which he expects to be affirmative, but which must in my view be emphatically negative. The question is: "May we, on the basal principle of relativity, give primacy in 'reality' to either set of events [optical records and their distant source-events], . . . since each is acknowledged as physically 'real' in the same sense?" Surely the answer is that the source-events are, in the theory of relativity, four-dimensional, while the optical records in any aspect of them are only two-dimensional, and the latter cannot therefore have primacy. To say that it is indifferent which we regard as primary, because both are real in the same physical meaning, is like saying that because the map of a country is physically real in the same meaning as the country of which it is the map, we may therefore give primacy either to the country or to the map?

Can I have misunderstood my friend Prof. Lloyd Morgan? I should have thought he would have agreed that his question had been finally answered in Berkeley's "Theory of Vision."

In directing attention to this one point I have observed the condition laid down in the first paragraph of the article, and have dealt only with the relation of two orders of physical reality. I have not raised any question concerning theory of knowledge.

H. WILDON CARR.

The Athenæum,
Pall Mall, S.W.1.

SINCE "Theory of Knowledge" opens up very wide issues, I sought to focus one salient point, namely, psychological reference. No doubt we here come down in the long run to the nature of mind and its relation to physiological events in the body. But my aim was to deal with the retinal record as what Prof. Whitehead calls a percipient event or a sensorium, that is, a state of the body. The question I raised is this: What is "the mind" in some way up against in vision? Is it the percipient event as record? Or is it the distant event with which this percipient event is co-related?

Believing that physical relativity is concerned with *this* co-relation, I led up to sundry questions. Prof. Wildon Carr in his courteous letter regards as crucial the answer to one of them (No. 6). The external "source-events" are, he says, four-dimensional; but

" the optical records in any aspect of them are only two-dimensional, and the latter cannot therefore have primacy."

I find it difficult to understand in what aspect the record on the retina *as a curved surface* is two-dimensional only. I submit that for fruitful co-relation any percipient event is four-dimensional. When, owing to retinal curvature, that which on other grounds we call a straight line is for appearance in some measure deformed, the question arises: Which are we to acknowledge as "really" deformed, the something out there or the percipient event in the record? On the basal principle of physical relativity, may we give primacy to either?

C. LLOYD MORGAN.

Organisation in Chemical Societies.

IN spite of Prof. Philip's able defence (NATURE, October 25, p. 609), it must be confessed that Dr. Travers' objections have much point. It is surely the main business of the Chemical Society in the first place to publish the discoveries of its members, and in the second place to maintain a reference lending library for the benefit of its members. It is doubtful if it should undertake the publication of Abstracts or of Annual Reports unless these pay their way. This is educational work simply, and might reasonably, especially in view of the great industrial importance of chemistry, be financed out of public funds. A Government Department, such as that of Scientific and Industrial Research, might quite well be expected to undertake the publication of chemical abstracts, of chemical patents similar to the publication of Friedländer, and of chemical books of reference, organic and inorganic, frequently revised, on the lines of Beilstein and Stelzner.

J. E. MARSH.

University Chemical Laboratory,
Oxford, October 28.

PROF. PHILIP would have been well advised if he had struck out the last paragraph of his letter in NATURE of October 25. He may have found it satisfying, but it does not accord with the usages of professional controversy, nor does it strengthen his reply to my criticism.

I must point out that I did not attempt to deal with the finances of individual societies. That the Chemical Society has temporarily waived its entrance fee has nothing to do with the fact that 15*l*. is an undue tax on chemists who wish to belong to British chemical societies. Prof. Philip practically admits that American Chemical Abstracts are superior to the British equivalent. They cover "a wider area," a fact which, for some reason he does not give, he does not consider to be an advantage. They are published as a whole in *octavo* size, instead of half in *octavo* and half in *quarto*. One does not have to walk from one set of shelves to another to look up references in any one year. If Dr. Philip will accept a constructive suggestion, it is that his Committee should follow the lead of the United States in these respects.

My experience of the Chemical Society's library has been unfortunate. I have frequently been told that I could not have direct access to series of journals, because members were not admitted to the room where the journals were kept, because indexers were working in the room, etc. As to the meeting-room, on this point Prof. Philip is silent; most members of the Society are inclined to eloquence on the subject.

This state of affairs will continue so long as the various chemical societies continue to cherish their individuality to the extent of preserving absolutely distinct offices, staffs, etc. At the moment they may be co-operating on paper; actually they are in active competition for members, using all the art of advertisement, including the unique offer of some of the cheapest chemical qualifications in the world.

M. W. TRAVERS.

147 Queen Victoria Street,
London, E.C.4,
October 29.

The Physical Nature of Verse.

IF Prof. E. W. Scripture (NATURE, October 11, p. 534) had said that *normal English* verse was *mainly* a matter of rhythm—instead of saying that verse is purely a matter of rhythm—he would have been in line with ordinary opinion to-day. I have myself taught this, at Cambridge and elsewhere, for a quarter of a century. Prof. Scripture contributes nothing new except his method of research and the unnecessary word "centroid." His conclusion is too sweeping, and at the same time defective. The works of Homer, Pindar, Virgil, Horace, and Ovid are verse; and in them we are obliged to take account of quantitative feet. Shakespeare's blank verse line is rhythmic; Milton's is rhythmic and quantitative as well; both observe the principle of number. One of the great æsthetic principles, that uniformity shall admit of variety, so that we receive a continual satisfaction of expectation, mingled with recurrent surprise, would be thwarted if verse were written solely on Prof. Scripture's principle.

Old English verse was of this type:

Áthelstan sóvran	of eárls the lórd,
Bárons' beígh-gìver,	and his bróther álso,
Édmund Átheling	of éndless fáme
Slέw in báttle	with their swórds' édges
Thére at Brúnanbùrgh.	

Each half-verse had two stresses, and would admit a third, a half-stress; and the two were linked by alliteration.

Geoffrey Chaucer dropped the alliteration, introduced rime, number, *and the suggestion of musical rhythm*. He wrote, for instance:

Whán that Aprílle	with his shoúrës soótë
The dróghte of Márche	hath pérced to the roótë,
And báthëd èvery veíne	in swích licoúr,
Of which vertú	engéndrëd is the floúr . . .

He managed the suggestion of musical stress by keeping two rules: (1) a stress must fall either on the fourth or the sixth syllable, unless stresses fall on the second, eighth, and tenth; (2) a stress must always fall on the tenth syllable, and it must be a full stress unless a full stress has fallen on the eighth syllable. In this way he combined the free rhetorical rhythm of the pure English verse with the (substantially indicated) musical rhythm of certain foreign verse.

Nearly all our good verse, everything that can be called classical, combines these two principles.

As for the ancient classical feet, when we mention them nowadays in describing English verse we use a certain licence. By "anapæst" we do not mean two short syllables followed by a long syllable, but two unemphatic syllables (interstresses) followed by an emphatic syllable (a stress). In that sense, for example, Swinburne's chorus in *Atalanta*, "When the hounds of Spring are on Winter's traces . . ." may be described as anapæstic.

Curiously enough, Prof. Scripture (in my view) marks

mistaken emphasis in one of the two examples in which he exhibits his "centroids." Hamlet's line would run :

To bé or nót to bè : thát is the quéstion.

Prof. Scripture is right in exalting rhythm as a main principle in English verse. He is clearly wrong in saying "it has no metre." E. W. LUMMIS.

S. Margarets-at-Cliffe,
Kent.

The Spectrohelioscope.

IN the issue of NATURE for October 25, p. 628, is published an article by Prof. G. E. Hale on the spectrohelioscope. It may be of interest to readers of NATURE to know that, so early as 1912, I made experiments with such an instrument, using a rotating disc in which was cut a number of radial slits. Preliminary experiments were made and a rough model was constructed by the kind help and suggestions of Mr. F. Twyman, who also described the method to Prof. R. W. Wood. Unfortunately, owing to the pressure of more important work, these experiments were abandoned and the model dismantled, but not before certain conclusions were arrived at.

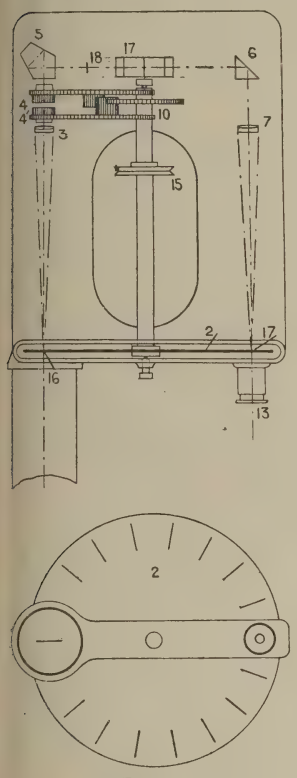

FIG. 1.

In January of 1923 the matter was taken up again and a series of measurements made and experiments carried out, to see if an instrument could be designed and constructed. There are certain difficulties to be met with, and one of these is to maintain an exactly similar movement of the image of the collimator slit on the corresponding slit passing in front of the eyepiece, but this can be overcome. I do not see any reason why a spectrohelioscope built on rotating sector principle should not give excellent results, and there are further uses to which such an instrument could be applied.

A drawing of one of the models suggested was forwarded to several British astronomers in June 1923, including Prof. Fowler, of the Imperial College, who also commented favourably upon it. Fig. 1 is from a drawing of one of the instruments proposed. In place of the compound prism shown, a replica diffraction grating can be used with advantage.

The instrument consists of a rotating disc (2) in which are cut a number of radial slits. The light which forms an image of the sun or other object comes to a focus on the rotating disc at (16). The light passes through the slit and is collimated by the object glass (3), and passes through the deflecting system (4) and (4′) and the pentagonal prism (5). The dispersing element (17) is a high dispersion compound prism which forms an image by means of the object glass (7) on the disc at position (17). This slit image will be in monochromatic light and will pass out through the slit at (17) into the observing eyepiece (13).

When the instrument is in use, the disc (2) is rotated, by means of the pulley (15) and an electric motor, at a speed which will eliminate flicker, and the object is then seen in monochromatic light corresponding to that for which the compound prism is set. When light of a different wave-length is required, a suitable deflecting prism is interposed at (18). The degree of purity will, of course, depend on the width of slits employed. The deflecting prisms (4) and (4′) are used to correct small errors of deviation due to the dispersing prism (17) and are driven by suitable gearing to make one complete revolution as the entrance slit passes the object.

F. STANLEY.

Bellingham and Stanley, Ltd.,
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Abney Sectors in Photometry.

IN the issue of NATURE for September 27, p. 466, there appears a letter from Mr. G. F. Wood describing, with illustration, a type of photometric sectored disc, the transmission of which is a function of the distance from the centre of the disc.

It may be of interest to Mr. Wood and to readers of NATURE to know that a disc of exactly this type was invented by Dr. E. P. Hyde in 1912, and described in an article in the *Astrophysical Journal*, vol. xxxv., No. 4, May 1912, page 237.

It should be noted that this type of disc can, in general, be used only where the light beam is of small dimensions compared with the dimensions of the disc ; otherwise, there will be a non-uniform field of view. The disc invented by Dr. Hyde was intended for use with a spectrophotometer where the light beam is limited by the width of the slit.

In this connexion, I understand that the firm of Franz, Schmidt and Haensch, makers of photometric apparatus, list Dr. Hyde's disc in their catalogue as an auxiliary to their spectrophotometer.

FRANCIS E. CADY.

Nela Research Laboratory,
Nela Park, Cleveland, October 16.

Popular Science Exhibitions.

YOUR commendation of the Royal Society's Exhibition of Pure Science at the British Empire Exhibition, Wembley, will, I feel sure, be welcomed by all readers of NATURE. I hope you will allow me to suggest that it might be supplemented by a word of praise for the scientific chemistry exhibits, which, owing to the admirable enterprise and liberality of the chemical manufacturers, were detached from the science exhibits of the Royal Society and placed as a sort of intellectual heart in the centre of the fine display of manufacturing chemistry in the Palace of Industry. Incidentally also, this gave rise to the striking book on "Chemistry in the Twentieth Century" and to the publication of a series of popular pamphlets which have had a large sale in the Exhibition.

It is right to add a word of acknowledgment of the debt due to Mr. W. J. U. Woolcock, the manager of the Association of British Chemical Manufacturers, for the great part he has played in putting so clearly in evidence the creditable state of British chemistry, both pure and applied. A. S.

If the Earth went Dry.[1]

By Sir NAPIER SHAW, F.R.S.

THE various countries of the globe differ from one another in respect of dryness, though none are literally dry, year in and year out. Still some are very nearly dry; others are moist, and some, comparatively speaking, wet. Herein consists one of the main causes of the complication which students of the physics of the atmosphere have to face.

For a meteorologist, water in the form of vapour is the most important constituent of the atmosphere; it provides not only the material for clouds, rain, snow, and hail, but also the means of supplying the energy which makes those things possible. Recent investigations have made it clear that the important functions attributed somewhat loosely in meteorological literature to warm air really belong to the water vapour which the warm air carries. We may well therefore ask the question, "What on earth should we do without water?" What would meteorology be like if its warm air were never saturated and never could be saturated? The answer to the question is, "Very little would be left; but still something." It is that "something" to which I wish to direct attention. "What would be left of meteorology if the earth went dry?"

As a subject it is, of course, hypothetical. Water is an important constituent, not only of the atmosphere but also of all living material, so absolute prohibition in the sense in which I am using the term would put an end not only to that part of meteorology which I may call the joy of its life, but also to life itself in any form. So far as I know, it would be futile to put the question to a biologist. It is not so for the meteorologist. Although the most familiar conception of the meteorologist, the spontaneous ascent of warm air through its environment by what is called convection, would disappear, there would still remain quite unimpaired and even enhanced the spontaneous descent of air by cooling on a mountain slope and also a peculiar form of the ascent of warmed air by the building up of a layer of air in convective equilibrium—a new conception of considerable interest which gives a true representation of the convection of warm air as distinguished from saturated air.

A General View of Atmospheric Structure.

I start from a certain idea of atmospheric structure, which, though not novel, may require setting out. I will ask you to regard the meteorological atmosphere as being an envelope of some twenty kilometres' thickness, with a structure of the same type as the stratosphere which has been identified in our own upper atmosphere. By a stratosphere I mean a thermal structure expressed by approximately vertical isothermal surfaces which surround the polar axis like a series of collars projecting vertically outward from successive parallels of latitude. Such a structure would require a certain circulation of air, in order to balance the distribution of pressure which is inevitable when there are vertical columns of different temperature; but that being provided, the structure would be an extremely stable atmosphere, impenetrable by any convection. That is as it should be; because the structure is only possible if vertical convection is ruled out. Vertical convection of any sort would mix up the layers and transform the isothermal structure into some sort of approximation to the labile state of convective equilibrium. Any convection would be a step in that direction.

Taking the structure of the stratosphere as the original idea, we may say that the lower layers of our own atmosphere have been modified by convection, with the aid of water vapour, and have been converted into a state which approximates much more nearly to that of convective equilibrium than to the isothermal conditions of the stratosphere. The part of the atmosphere thus modified we call the troposphere. In this region temperature is arranged in layers which are nearly horizontal instead of in nearly vertical sheets or columns. Our present troposphere is not uniformly thick; it extends from the surface of the earth upward through about seventeen kilometres in the equatorial region, and about half that height at the poles. Its upper boundary, called the tropopause, may be said to mark the present limit of the operation of convection. If convection became more active, the troposphere would be enlarged at the expense of the stratosphere; if on the other hand convection became less active, the boundary would be lower, the stratosphere would come down nearer to the earth; and if there were no convection at all, the atmosphere would be all stratosphere.

We may therefore regard the troposphere as the result of persistent excavation by quarrying, carving, or nibbling of the under side of a stratospheric atmosphere by convection of one sort or other which originates in the warmth and moisture developed at the earth's surface or the loss of heat in the absence of the sun. In our present atmosphere convection is largely dependent upon water vapour, hence our first conclusion is that if there were no water vapour, the excavation would be greatly reduced and the stratosphere would be brought down much nearer to the surface and only interfered with by such convection as belongs to dry air.

It is possible that in the course of years this reduction of convection might affect the temperature of the stratosphere but its immediate results would be limited to the troposphere, and its effects upon the body of air comprised within the troposphere are dynamical as well as thermal. The troposphere may be said to form the flywheel of the atmospheric engine. It is in a state of perpetual motion, which we call the general circulation of the atmosphere, as the dynamical effect of heat received from the sun by radiation, communicated chiefly at the ground level and afterwards radiated into space from the earth's surface and the atmosphere. The working of the atmospheric engine would be much simplified if there were no water vapour, because then, without serious error, the atmosphere might be regarded as perfectly transparent both

[1] Paper read before Section A (Mathematics and Physics) of the British Association at Toronto on August 8.

or the solar radiation by which the heat is gained and or the terrestrial radiation by which the heat is lost.[2] Loss or gain would take place only at the surface and the balance of loss or gain of heat would be the result of a comparatively simple account.

The Balance of Gain and Loss of Heat.

As a prelude to the question of downward convection, which is applicable equally to dry air and moist air, let us examine the question of the balance of gain of heat from the sun and the loss of radiation from the ground.

Taking a station such as Davos, the diurnal and seasonal isopleths of the intensity of solar radiation, which is referred to a surface normal to the sun's rays, shows that the diminution of the intensity with the increasing obliquity of the sun's rays is due to absorption by the atmosphere, principally by water vapour. If there were no water in the atmosphere, the intensity of solar radiation would reach and remain at the amount indicated by the solar constant throughout the period of sunlight, changing instantaneously to zero with the disappearance of the sun at sunset and recovering its full activity at sunrise. That activity is about 1·93 gram calories per square centimetre per minute, equivalent to 135 kilowatts per square dekametre or 1·35 kilowatt (2 horse-power) per square metre.

I digress for a moment to direct attention to the vastness of the power of the sun. Some days ago, looking at the Montmorency Falls, a distinguished engineer suggested that the energy represented by the Falls might be 20,000 horse-power. The power of sunlight upon an area of 200 yards by 100 yards, about four acres, would exceed that amount—if the whole of the energy of sunlight could be converted into work, as practically the energy of a waterfall can be.

We have supposed the area to be at right angles to the sun's rays. To get the amount on a square dekametre of horizontal surface, we must multiply the figure for normal incidence by the sine of the angle between the sun's rays and the horizontal surface, the sine of the sun's altitude. As the sun recedes from its noon altitude the intensity of its radiation decreases gradually from its noon value to zero when at sunset the sun is at grazing incidence.

To set against this gain of energy by solar radiation we have the loss of heat by radiation into space, which, if the atmosphere be perfectly transparent (as we will assume dry air to be), depends upon the fourth power of the temperature, and nothing else, except the radiating power of the surface. Taking that radiating power as that of a perfectly black body, as we may fairly do if there is no ice or snow, the loss of heat by radiation according to Stefan's law is σt^4 where t is the absolute temperature and σ is a constant, namely, $5{\cdot}72 \times 10^{-12}$ watts per square centimetre.

Thus we get the following table for the sun's altitude when there is a balance of solar and terrestrial radiation for a horizontal surface:

Temperature.		Sun's Altitude for Balance.	Temperature.		Sun's Altitude for Balance.
Tercentesimal.[3]	Centigrade.		Tercentesimal.	Centigrade.	
200	−73	3½°	310	+37	20¾°
210	−63	4¼°	320	+47	23¾°
220	−53	5 °	330	+57	27 °
230	−43	6 °	340	+67	31 °
240	−33	7¼°	350	+77	35¼°
250	−23	8½°	360	+87	40 °
260	−13	10 °	370	+97	46 °
270	− 3	11¾°	380	+107	53¼°
280	+ 7	13¾°	390	+117	62¼°
290	+17	15¾°	400	+127	79¼°
300	+27	18 °	402	+129	90 °

The Upward Convection of Dry Air.

Since the air is dry it must necessarily cool on rising to the maximum extent of 1t per 100 metres. It can only penetrate the air above it if the lapse rate of the environment is of the same magnitude. That is the condition for what is called convective equilibrium (Bjerknes's barotropic condition). Consequently, upward convection by warmed air can only occur by building up a layer in convective equilibrium; and then, an infinitesimal increase of temperature at the surface would cause the passage of the warmed air to the top of the existing convective layer and its subsequent extension with only an infinitesimal difference of temperature beyond the existing top. When the penetrative convection caused by water vapour is non-existent, we are limited to this gradual piling up of a layer which differs only infinitesimally from convective equilibrium and increases in thickness with the continuance of the solarisation of the ground. Certain amplifications of this statement are necessary when the solarised surface is not horizontal, and locally when the angle of elevation varies from place to place; but, subject to that reservation, we may understand that if the earth were dry, upward convection would mean the compilation of a layer of air in convective equilibrium.

We may ask how far the layer would extend under given conditions of solarisation and the answer depends upon the condition of the atmosphere when the solarisation begins. From our knowledge of the maximum and minimum temperatures in a dry atmosphere, such as that of Egypt, we may conclude that the convective layer which is formed during the day is abolished during the night by the turbulence due to winds operating upon the surface layer cooled by terrestrial radiation from the ground.

For the present, let us suppose that the diurnal range at the ground is 20t (the normal range at Helwan), and that this range falls off uniformly with height until the undisturbed level is reached. Let h be the height of that level and let d be the mean density of the column. Then by equating the amount required to warm the atmosphere with the heat gained during a day under a sun which is vertical at noon, and

[2] This statement may be admitted for the purpose of computation in this paper, although, according to observations of Anders Ångström, "the perfectly dry atmosphere has a radiating power as great as 50% of the radiation of a black body at the temperature of the place of observation" (Smithsonian Misc. Coll., vol. 65, No. 3, p. 88, 1915).

[3] Tercentesimal temperature is the temperature measured in centigrade degrees from a zero 273 degrees below the normal freezing point of water. It is approximately equal to the absolute or "Kelvin" temperature, but there is a technical difference between the two which cannot always be ignored. In this as in other papers a unit step on the tercentesimal scale is denoted by t.

allowing for a loss by outward radiation to the extent of that corresponding with the mean temperature for Helwan, we get an equation for h. This equation can be solved with the aid of the pressure equation and gives approximately 2 kilometres for the height of the daily convective layer at Helwan.

Similar equations can be got for other latitudes, and by considering the case of a conical surface in the polar regions with its vertex 2 kilometres above sea level and a base of 500 kilometres radius.

We proceed from the knowledge that a slope is required in order to cause a downward flow at all, and that in the polar regions a pool of cold air is formed during the seasonal night with the coldest air at the bottom, in spite of the fact that descending air is automatically warmed to the extent of 1° for every 100 metres of descent. We assume further that

The Downward Convection of Dry Air: Katabatic Winds.

Downward convection along a surface which is losing heat by radiation will proceed with undiminished or even increased intensity when the earth is dry, and we may form a rough estimate of the result of the process

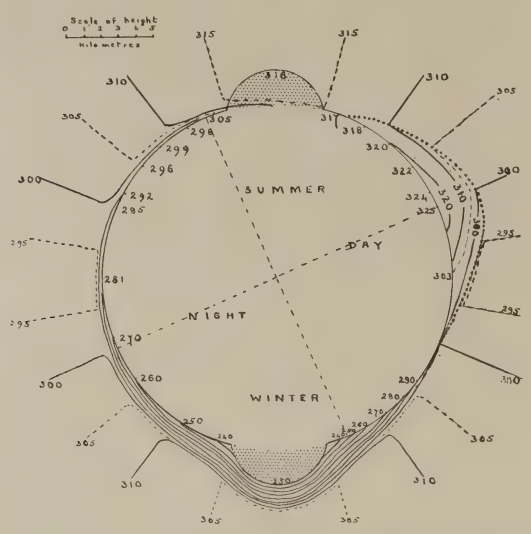

FIG. 1.—Distribution of temperature in a dry atmosphere at the northern solstice on a globe with hemispherical polar caps.

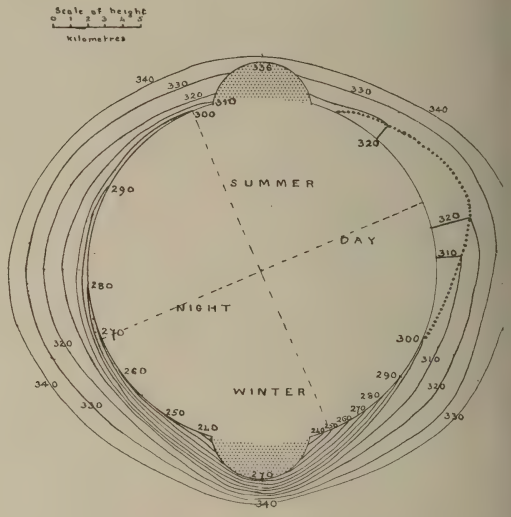

FIG. 3.—Distribution of potential temperature corresponding with Figure 1.

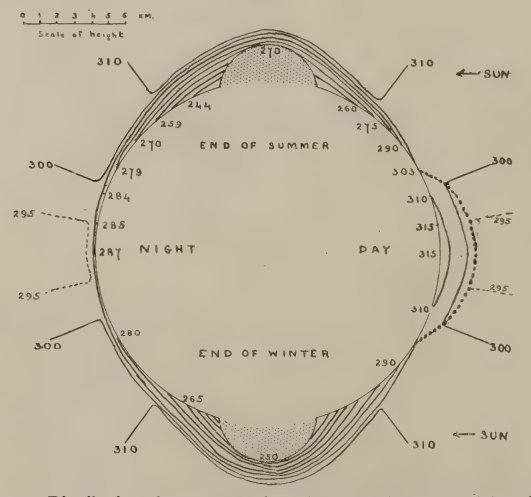

FIG. 2.—Distribution of temperature in a dry atmosphere on a globe with hemispherical polar caps at the autumnal equinox of the northern hemisphere.

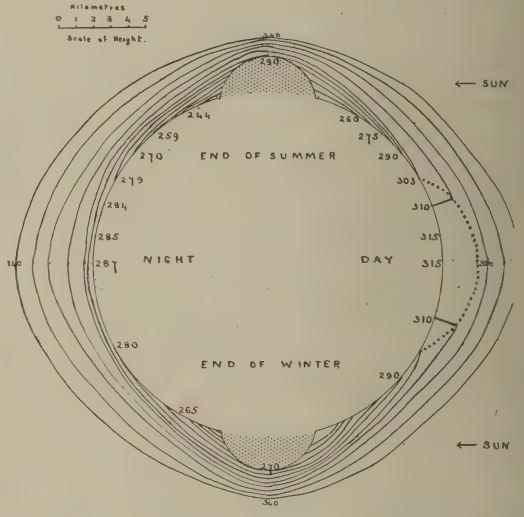

FIG. 4.—Distribution of potential temperature corresponding with Figure 2.

The boundary of the convective atmosphere is indicated in each diagram by a line of dots.

the average height of the convective layer works out for the year as follows:

Latitude	0	10	20	30	40	50	60	70	80	90
Solar radiation per day (gm. cal. per cm.²)	916	904	869	807	725	629	521	435	393	380
Height of the convective atmosphere (km.)	2	2	1·9	1·8	1·6	1·4	1·1	1·0	0·8	0·8

Mean values for the year have no real practical application for the polar regions, but let that pass.

ring the winter the air at the base does not get
sistently and continually colder from the first
idence of shadow to the end of night, but
ches a steady state in which the further cooling of
air at the foot of the slope is prevented by air
ning down under the influence of the loss of heat
m the slope. The descending air has its tempera-
e raised by the increase of pressure; but it loses
t to the cooling ground over which it marches.
dy convection will bring a certain thickness of the
cending current into contact with the ground.
e increased temperature of the descending air is
d to wash away, so to speak, the loss of heat by
liation from the whole slope. When a steady state
s thus been reached, if we suppose the temperature
the base to be maintained at 10t below that of the
nmit and the turbulence to be sufficient to mix up
surface air to a thickness of 50 metres, we find that
will be necessary to have a radial outflow of 300 km.
r hour over the periphery of the circle of 500 km.
lius in order to wash away the result of radiation
d keep the thermal balance.

That is a tremendous wind and perhaps we have cause
be thankful that the polar regions are not entirely dry.
ere is, of course, ample opportunity for mistakes in
e assumptions and even in the arithmetic; but no
anges either in assumptions or in arithmetic can, so
as I can see, enable us to escape from the con-
sion that katabatic winds on polar slopes are a very
l and very potent phenomenon of the atmosphere,
ich would certainly not be diminished by its
coming dry.

Diagrams of Temperature and Potential Temperature.

With the physical principles thus enunciated I have
deavoured to construct diagrams representing the
stribution of temperature and potential temperature
er the earth at the solstice and equinox, making use
the information about diurnal range and seasonal
riation given by extant observations in regions that
e approximately dry. I use both temperature and
tential temperature in consequence of the interesting
ciprocity between them. We have only three types
condition: stratosphere, convective equilibrium,
d downward convection. In the stratosphere, iso-
erms are vertical, lines of equal potential tempera-
re horizontal; in the convective equilibrium, exactly
e reverse is the case. Where downward convection
maintained there is horizontal stratification with
version of temperature.

As illustrations of the material upon which the
ures of the diagrams are based, I quote the following:
1. Seasonal variation of thermal structure of the
lar atmosphere at Maudhavn, North Siberia, Lat.
½° N. from H. U. Sverdrup, Maud-Ekspeditionens
denskabelige Arbeide, 1918–19.

Temperatures at various Dates.
(Tercentesimal Scale.)

eight in Metres.	Feb. 26.	Mar. 22.	April 11.	June 17.	July 11.
0	229	241	253	274	280
200	239	240	251·5	272·5	279
1000	246	247	259	271·5	274

There is transition from continuous and very rapid *increase* of temperature with height, 17t for 1000 metres, in February (before sunrise) to the common *lapse-rate* of the world, 6t for 1000 metres, in July.

2. Data for diurnal range of temperature in July in dry tropical regions.

Diurnal Ranges.
(Tercentesimal Scale.)

	Mean.	Mean Max.	Mean Min.	Abs. Max.	Abs. Min.	Period.
Wadi Halfa .	304·4	313·8	296·2	322	290	1902–20
Helwan . .	300·3	308·4	294	315·9	289	1904–20
Salt Lake City	..	309	284	312	279	..

On the principles mentioned and with data of this kind culled from various sources, I have made out diagrams of the distribution of temperature in a dry atmosphere at the solstice (Fig. 1) and at the equinox (Fig. 2); also the distribution of potential temperature at the same epochs (Figs. 3 and 4).

The General Circulation of a Dry Atmosphere.

Finally, we have to consider what the circulation of the atmosphere would be in the supposed conditions of dry air. Looking at the diagram of the distribution of temperature, we see that an arrangement of the vertical columns of air round the pole would be the dominant feature, and therefore a vigorous west-to-east circulation round the pole in the upper atmosphere of the higher latitudes, compensated, as it must be, from the principle of conservation of moment of momentum, by a west-to-east circulation partly in the equatorial region.

There is also the flow of air down the polar slopes, which will certainly simulate the procedure which we attribute to the polar front. In the dynamical effects which they produce, the elevations at the poles are indeed the equivalents of very vigorous anticyclones, and the revolution of the earth will take care that the currents which they feed shall produce a circulation opposite to the westerly circulation under which they are formed.

There will be the discontinuities of temperature and of wind velocity typical of the polar front and the corresponding dynamical effects. Even if the earth went dry, the weather of the world would be of the same type as now in respect of general and local circulations; only as regards intensity would those circulations be affected.

If this conclusion be accepted, as I think it must be, we have next to think out what, after all, the effect of restoring the water would be, and then we shall have made a schematic representation of real weather. The thermodynamical aspect of the subject is treated in a paper on the energy of saturated air in a natural environment for the International Mathematical Association, in which the convective energy of a kilogram of air in virtue of its full complement of water vapour is represented by the area enclosed between the curve of environment and the adiabatic curve of saturated air drawn through the point at which saturation is assumed to exist. The amount of energy thus represented is found to vary from zero to 10,000 joules or more per kilogram.

Acoustical Problems.

By Major W. S. TUCKER, D.Sc.

OF all branches of physics, acoustics has probably been the most neglected of recent years; and although a good deal of work is being done in America, the number of investigators working in acoustics in Great Britain is surprisingly small. The War caused a temporary revival of interest in certain aspects of the subject, and a number of papers of scientific value were produced as the result of the application of acoustical methods to the location of submarines, guns, aeroplanes, and mining activities. Very few of the large personnel, however, who were engaged in these problems have continued in this work. Return to the universities of those engaged in teaching and research resulted in a resumption of their pre-War activities.

Yet there are many problems well deserving of systematic study. To give one illustration, the study of the properties of collectors of sound such as trumpets —and all those aspects of sound distribution in which the wave-length is comparable with the dimensions of the object—require further development by the mathematician, although the cases of obstacles large or small as compared with the wave-length have been adequately dealt with. In experimental acoustics many physical laboratories used for instruction are only equipped with apparatus of a very elementary character, and after a brief course in the first year, the students cease to take any further interest in that branch of physics. The shortage of text-books on the subject is another feature, and it is scarcely possible to appreciate how much work has been done in recent years, except by a laborious study of scientific journals, few of which are available in the average college library. Yet there is a growing demand for the solution of problems which are beginning to affect our everyday life, and the calling of "acoustical engineer," or "consultant in acoustics," should be among the professions worthy of a more definite place.

Our mode of locomotion largely involves the production of rapid explosions—only too often inadequately silenced—and our main roads are more noisy than the railroad tracks. In the neighbourhood of our busy aerodromes, noise is continuously distracting, and our quiet countryside has been invaded by the sounds of the low-flying continental traffic.

Our halls and council chambers, now that wood ceases to be an indispensable part of the walls and ceilings, are so resonant that much expense has been entailed in remedying their poor acoustical properties, and if further problems need be cited, the distortion of our speech and music by "loud speakers" is surely a matter requiring something more than the experimental investigations undertaken by commercial firms.

These are only a few of the problems the solution of which will almost certainly be found in the physical laboratory, but in order that they may be dealt with effectively, some attention must be paid to the perfecting of acoustical measurements. The researches of Harvey Fletcher, Knudsen, Minton, and other American physicists have shown what are the limitations of the ear, and although no instrument could be devised combining the extreme sensitivity and large musical range of that organ at the same time, th is ample evidence to show that the ear either absolute or relative measurements should not relied upon. Electrical methods of comparison m ultimately be used, and microphones must be devis in which some simple law must connect the intens of the measured sound with the effect it produc There is a great need for a source of sound which c be accurately reproduced, and can serve as an arbitra unit, worthy to be included among the standards a basis of physical measurement.

One of the chief problems in acoustical research the provision of an acoustical laboratory. If a clos room is chosen, the distribution of sound in the roc is so strongly affected by reflexions of the walls th nearly all experiments involving sound measureme are vitiated. If a siren be employed as a source sound, and the pitch is gradually raised, a given poi in the room may give a maximum of intensity f one note and a minimum for a note of another pitc This effect is overcome to some extent by "lagging the walls of the room with sound-absorbent materi but the effect can still be distinguished, and if o attempts to obtain resonance curves for any acoustic apparatus, these curves will be distorted.

The only means of working satisfactorily is to experiments in the open air, and in spite of difficulti with wind and varying temperature, and possib extraneous noises, good results can be obtaine Measurements of absorbing powers of differe materials have been made, by Wallace Sabine and h associates, by employing rooms in which elabora precautions have been taken to insulate them fro the outer air. In this case values have been deduce from the period of reverberation, the ear being en ployed as the means of estimating the duration the effect. Not only have absorbing powers bee measured, but also the experiments have been develope to such an extent as to measure deafness, and qui recently to estimate the amount of energy given ou by various musical instruments, and by the huma voice. Values of absorbing power for differer materials have been obtained with sufficient accurac to enable architects and builders to improve effectivel the acoustic properties of halls and churches. Tes of reverberation are difficult to carry out if there ar disturbing sounds in the neighbourhood. It is reason able to anticipate that with a pure note source sound and a tuned microphone for reception, mor accurate methods could be devised for measurin reverberation periods—methods which will ignor the "jamming" effect of outside noises.

One of the chief problems in acoustical measure ment is the design of a source of sound in which th note is pure, and the output is fairly uniform through out a reasonable range of musical notes. Develop ments in wireless have introduced to us a very usefu generator of sound in the thermionic valve and it appropriate electric circuits. Alternating current closely approaching a simple harmonic character hav been generated, and the alteration in pitch is accom plished by the simple adjustment of inductance o

pacity. By a process of "heterodyning" familiar to the wireless expert, Cohen has been able to produce a very constant output for cycles varying from 50 to 5000 per second, and these oscillatory currents can be used to actuate "loud speakers." If only the loud speaker were devoid of resonance properties, the problem above referred to would be effectively solved. Another useful piece of apparatus has been designed by E. A. Milne and Fowler in which the simple Seebeck siren is converted into a pure tone generator by so shaping the holes of the disc as to cause the flow of air to alter in quantity by a simple harmonic relation with time. If the pipes supplying the air can be made non-resonant this source of sound is probably the best available. An attempt is being made to devise pure tone centrifugal sirens in which pipes for conducting the air past the ports of the rotating part may be dispensed with, but here we have the disadvantage that acoustical output increasing with the frequency of the note. With apparatus of this character and with suitable microphones, accurate resonance curves can be obtained for various sound receivers.

There are problems of sound transmission through the air which involve large scale experiments and the accurate knowledge of upper winds and temperatures. These might be considered under the heading of meteorological acoustics, and they are of increasing importance in long-range listening for aeroplanes. The work of Tyndall, Osborne Reynolds, Rayleigh, and, more recently, Van Everdingen and E. A. Milne, have resulted in the explanation of those phenomena of variation of range for sounds up-wind and down-wind. Milne has obtained expressions for range and corrections for refraction due to variations of upper wind and upper temperature when these follow a linear law. Explanations of zones of silence at some distance from the source have also been afforded. The Acoustical Section, working for the three Fighting Services and the Department of Scientific and Industrial Research, has been able to verify experimentally some of these laws, and the latter have been very helpful in the design of directional sound-receiving apparatus.

One of the features of recent developments in acoustics has been the production and improvement of the Service sound locators for detection and location of aeroplanes. These instruments will not in general point to the source of sound owing to (1) lag of sound, if the source is a moving one, and (2) the departure of the wave front from the spherical owing to refraction due to wind and temperature variations. The ease with which these instruments can be used depends on the structure of the atmosphere in which, apart from refraction due to the above causes, there are irregularities due to local temperature and humidity variations, and local whirls and eddies.

These variations in the medium have all been grouped under the heading of "acoustic clouds." Contrary to what might be expected, these acoustic clouds are most in evidence on a warm sunny day of good visibility, and are undoubtedly due to unequal heating from the sun's radiation. After sunset these clouds dissipate, and we get, not only good listening as regards range, but also greatly improved powers of finding direction. The blurred acoustical image becomes well defined. On the other hand, a uniform fog is acoustically clear and it is only on the fringes of the fog that sound absorption takes place. Experiments have recently been performed with aeroplanes in which some idea of the dimensions of the acoustic clouds has been deduced. These have been obtained by taking a photographic record of the sound obtained from an aeroplane in flight, and observing the periodicity of the sound fluctuations.

One of the outcomes of the study of meteorological conditions has been the fixing of an "acoustic skyline," which, under adverse wind conditions, always lies above the visual skyline. A source of sound moving through the air may be observed to rise or set over the skyline, with a definiteness almost as complete as the rising and setting of the sun, and when the sound is below the skyline a kind of acoustic twilight is produced. At this stage sense of direction is lost, the sound is diffused, and only arrives at the observer or microphone by scattering.

Other problems involving big scale experiments are connected with the production of powerful directive sources of sound, and include the breakdown of the air as a medium of sound transmission when the displacements due to the source of sound become large.

The foregoing statement merely provides a summary of those problems which are engaging the attention of research workers in acoustics, but they may serve to indicate how very fruitful is this field of investigation for the expert experimental physicist.

Obituary.

MR. A. E. CRAWLEY.

THE death took place on October 21 of Alfred Ernest Crawley, who was well known as the author of several works on anthropological matters. He was born in 1869, the son of the Rev. Samuel Crawley, Rector of Oddington, Oxford, was educated at Sedbergh and Cambridge, and entered the scholastic profession; he abandoned this for journalism in 1908. An adept in several branches of sport, his works on tennis and ball games are of recognised authority. In anthropology, besides contributing to the journals of several scientific societies, to NATURE, and to Hastings's "Dictionary of Religion and Ethics," he was the author of three books of some importance—"The Mystic Rose, a Study of Primitive Marriage," published in 1902; "The Tree of Life, a Study of Religion," published in 1905, and "The Idea of the Soul," which appeared in 1909. Of these "The Mystic Rose" was the best known—it undoubtedly exercised no inconsiderable influence on the anthropological thought of that day, especially in so far as it emphasised the importance of marriage ceremonies, a side of the subject to which Westermarck had then paid too little attention in his monumental study of human marriage.

Certain characteristic lines of thought are common to all Crawley's books, and indeed so early as 1895 he had outlined in the Journal of the Anthropological

Institute his fundamental principle that the aim of analysis of social institutions and religions should be to arrive at the mental attitude of primitive man towards his institutions and beliefs. In his view the study of marriage, for example, had been too exclusively sociological, and his book represented an attempt to bring marriage institutions and ceremonies as well as other primitive customs into the domain of psychology by defining the psychological needs which were satisfied by the magical or religious observances by which they were accompanied. Crawley's work was accurate and scholarly and was based upon wide reading and a critical appreciation of his authorities. Some at least of his work is of enduring value.

Dr. E. O. Hovey.

Edmund Otis Hovey, curator of the Department of Geology and Invertebrate Palæontology in the American Museum of Natural History, had just entered his sixty-third year when he was struck with paralysis in his office and died on September 27. In his younger days Dr. Hovey filled some teaching posts; he was brought by his installation of the mineralogical exhibit of Missouri at the Chicago Exposition to the notice of the American Museum, and entered its service in 1894.

Dr. Hovey was perhaps best known to geologists for his work in connexion with the eruption of Mont Pelé, Martinique, which took place on May 8, 1902. He was immediately sent as representative of the American Museum of Natural History, arrived at Martinique on May 21, and after distributing supplies to the impoverished inhabitants, spent about three weeks in studying the Soufrière on St. Vincent and four weeks on Mont Pelé. His results were published a preliminary report issued by the Museum in Bulletin on Oct. 11 of the same year. In Febru 1903 Hovey was again sent to note what changes h taken place and to extend his studies to the other rec volcanoes of the Caribbean chain; and again in 19 to bring the observations up-to-date. Other expe tions made by Hovey on behalf of the Museum were South Dakota and Mexico.

As museum curator Hovey took a keen interest his professional work, being responsible for seve attractive models in the public gallery. Though charge of the fossil invertebrata, he can scarcely considered a palæontologist. He did, however, c laborate with R. P. Whitfield, and with him produc the very helpful catalogue of the types and figur specimens among those fossils in the American Museu (1898–1901). We have lost in E. O. Hovey a usef worker, a cheery companion, and a constant friend.

F. A. B.

We regret to announce the following deaths:

Prof. W. A. Locey, professor and director of th Department of Zoology, Northwestern Universit since 1896, who was known for his work on th embryology of the nervous system, aged sixty-seven

Dr. Clara S. Ludlow, of George Washingto University and the United States Army Medic School, Washington, who carried out work in th Philippines on the transmission of disease b mosquitoes, on September 28, aged seventy-one.

Prof. G. Pruvot, honorary professor in the Facult of Science of the University of Paris, and formerl Director of the Laboratory of Marine Zoology a Banyuls-sur-Mer (Pyrénées-Orientales).

Prof. W. A. Macfadyen, professor of philosophy i the Transvaal University College, Pretoria.

Current Topics and Events

Great Britain is beginning to appreciate the importance of broadening the education of the mathematician and the scientific worker. In all subjects new knowledge has been and is piling up at a great rate. The universities demand more and more for a degree, and the student is constantly becoming more overloaded. At the same time, the lines of demarcation between the subjects are breaking down, and the importance for every scientific worker of a knowledge of allied sciences is growing greater every day. Sir William Pope expounded this idea in a lecture delivered in July last before the Royal Society of Arts. He pointed out the importance for chemists of a knowledge of physics and the need of a reform by which natural philosophy (that is, physics and chemistry) would become a single whole instead of being made up of half-a-dozen disconnected subjects. He would unite them into one by emphasising the fact that they are all based upon the electronic constitution of matter and energy. The importance of a knowledge of physics to the mathematician was emphasised at the conference held recently at the University College of Southampton, and the October issue of the *Mathematical Gazette* contains a valuable article by Prof. Piaggio on the subject. The main value of this article lies in the author's discussio of the means by which it can be made possible fc the mathematician to attain a knowledge of physic in addition to mathematics within a reasonable time He goes through the various branches of applie mathematics as at present taught at universities an picks out a considerable number of items that coul well be dropped in order to make room for mor important matter.

A correspondent sends us copies of the journal *La Province de Namur*, of June 1 and October 15 containing descriptions of a large pearl, reported b M. E. de Ceuster, of Moustier-sur-Sambre, to hav been found in a coconut. Where pearls come fron has always been a mystery in India, and so long ag as 1240 A.D., a Kashmir physician records them a coming from bamboos, coconuts, heads of elephants fish, etc. Pearls are definite animal concretions c carbonate of lime around a core which may be foreign body, the egg or some part of the body o the organism, or the egg or part of the body of contained parasite. True pearls only occur i molluscs, and they are microscopically and chemicall identical with the nacre—the inner lining of the shell—

all molluscs. Actually the structure consists of a ast number of very thin and corrugated laminæ an organic substance known as conchiolin, holding picules of carbonate of lime. The transparency, the verlapping of the laminæ, the corrugation, and the ngles of the lime spicules give the lustre so well hown in the precious pearls. Somewhat similar unded off concretions may be found in any animal's ody—as Bunyan says, "A pearl may in a toad's ead dwell"—but they are not found in plants, nooth and rounded off in this way. Concretions o occur in the latter, both of calcium carbonate and calcium oxalate, but they are generally rough, and e not formed in layers with a similar basis of onchiolin; a simple test for them would be the resence or absence of plant cellulose. In the East enerally the pearls formed by the giant clams of ne reefs are termed "coconut pearls," as their ppearance bears a resemblance to the cut surface f the kernel of the coconut; they often attain the ze of a pigeon's or small hen's egg, the clams themelves varying up to two feet across. Needless to ay, as they have no lustre, they are of no beauty nd of no value. Any plant concretion that may airly be termed a pearl would certainly be "new to cience."

THE presidential address given on October 23 to he Institution of Electrical Engineers by Mr. W. B. Woodhouse lays stress on the rapid growth of the lectrical industry during the last twenty years and ooks forward hopefully to the future. Mr. Woodouse makes the timely statement that electricity is ot a panacea for industrial and social ills, and so t behoves engineers to speak out just as definitely vhen unjustifiable claims are made for it as vhen it is unfairly attacked. In connexion with ducation, he made the interesting suggestion that a system of interchange of employees and staff etween manufacturers and supply undertakings would be of value to both sections of the industry. In his opinion, there is a direct obligation in the ndustry to bear the cost of post-graduate training by providing salaries which would be sufficient to encourage young men showing the necessary ability and energy to continue the widening of their experience beyond the normal period of their training. If this were adopted, the industry would benefit largely.

MR. WOODHOUSE then turned to another topic. Electricity is at the present time the cheapest form of illuminant. Its use, therefore, for lighting purposes is increasing at a rate never before equalled in the history of the industry. An important problem that has only been partially solved hitherto is the reduction in the costs of distribution to the average consumer. In general the cost of distribution adds 300 per cent. to the costs of production. It is interesting to note that the somewhat analogous case of distributing milk from house to house adds only 100 per cent. to the wholesale price. It is not generally realised that if the cost of fuel were halved, the reduction in the price of electricity would be trifling. Unfair comparisons are often made between Great Britain and other countries where the methods of transport are not so developed. For example, the carriage of coal from South Wales to London in order to generate electricity is more economical than transmitting the electricity by overhead wires from the coalfield. Mr. Woodhouse pointed out that the electrical industry, like all other human organisations, is changing, but that this is necessary if progress is to be made. He asked the younger engineers to continue that spirit of adventurous research which characterised the early pioneers.

THE American Institute of Sacred Literature—"an organisation for the promotion of popular study of the Bible and religion"—is inviting the co-operation of scientific workers and others in its efforts, and has produced a number of pamphlets written by leading men of science on the religious aspect of their work. We have before us an interesting little pamphlet by Prof. Edwin B. Frost, director of the Yerkes Observatory, entitled "The Heavens are Telling." Prof. Frost begins by stating and illustrating the enormous span of the material universe, the immense number of luminous objects which it contains, and the vast reaches of time required for their development, which must give to all who consider them a new and larger idea of the Cause behind them. After dealing with the exceedingly minute atoms and electrons which obey laws as definite and unvarying as the immense systems of the stars, Prof. Frost directs attention to the unity of the universe, as illustrated by the similarity of matter in the heavens and on the earth. This line of thought suggests that the combination of spirit and material body such as we possess may not be of great variety, and that we may not be vastly dissimilar from beings which may inhabit other planets circling around their appointed suns. Prof. Frost deplores the slow social development on the earth, particularly with respect to the evils of war, and considers that, from the planetary point of view, the most thorough application of the principles of Christianity seems to be the only way to bring our planet up to the moral standard to be expected of it. He contends that the scientific study of the material world tends to make spiritual conceptions less material, and divorces spirit from the material notions of mass, space, and time.

THE Christmas Lectures at the Royal Institution this year are to be delivered by Mr. Frank Balfour Browne, lecturer in zoology (entomology) in the University of Cambridge, the subject being "Concerning the Habits of Insects."

THE arrival of the German-built Zeppelin at Lakehurst, N.J., coinciding with the successful voyage to the Pacific coast and back of the airship *Shenandoah*, described in NATURE of March 1, p. 313, seems to have given a fresh impetus to American enthusiasm for the rigid airship. According to the *Engineer*, plans are now under discussion for the building of a series of these vessels, but of dimensions considerably in excess of any design so far evolved. Immediately on passing into American possession, the German Zeppelin, officially designated ZR3, was emptied of

the hydrogen with which she had been charged for the Transatlantic voyage, and had her gas cells refilled with helium. This is in accordance with the official American policy of forbidding the use of hydrogen in lighter-than-air craft under Government control. From a statement by Dr. R. B. Moore, former Chief Chemist of the United States Bureau of Mines, there is now in the United States a reserve of helium sufficient to keep filled and ready for service 200 airships of the capacity of the *Shenandoah*.

THE Fuel Research Board of the Department of Scientific and Industrial Research has for some time past been engaged in a general survey of the coal seams in all the coalfields of Great Britain with the object of classifying these according to their chemical and physical characteristics, and thus affording to the consumers valuable information as to the purposes for which each coal seam or each portion of a coal seam would be best suited. The first step in this direction was taken in the Lancashire and Cheshire Coalfield in co-operation with the local Coal Research Association, and the first result of this work has just been published in the form of a detailed report (London: H.M. Stationery Office, 2*s*. 6*d*. net) upon the Arley Seam of the Lancashire Coalfield. A good deal of useful information has been collected, the greater part of which was no doubt already in existence and available for those who knew where to find it, but it is a decided convenience to have the whole of this summarised and available in a compact and readily accessible form. There are a large number of illustrations, all of which, except the very useful map which forms the frontispiece, are photographs of coke produced under different conditions. It would be too much to say that these are useless and devoid of interest, but it is certain that the information which they convey is by no means commensurate with the expense of their production. It would have been better to have omitted these ten plates and to have published the pamphlet at a correspondingly lower price

MR. J. ELLIS BARKER, in the course of a further letter, writes as follows: "In your issue of the 1st November I protested that your reviewer, in dealing with my book, 'Cancer: How it is caused, How it can be prevented,' condemned my book on the basis of a number of serious mis-statements of his and of misrepresentations of my views which I enumerated. In a note appended to my letter your reviewer, instead of dealing with my arguments, describes my justified protest as a 'hymn of hate.' As he did not deal with my charge of mis-statement and mis-quotation, I imagine that your readers will draw their own conclusions." We agree with Mr. Barker that readers of NATURE, having read the review of Mr. Barker's book in our issue of October 4, p. 496, and also the correspondence on the subject which followed, may draw their own conclusions, and we are content to leave the matter thus.

DR. CHARLES SINGER, lecturer on the history of medicine at University College, London, is to deliver the Fitzpatrick Lectures of the Royal College of Physicians, London, on November 11 and 12. Dr. Singer will take as his subject "The History of Anatomy."

AN Economic Botanist with an academic knowledg of botany, and practical experience of plant breedin including paddy breeding, is required by the Gover ment of Madras. Particulars may be had from th Secretary to the High Commissioner for India, 4 Grosvenor Gardens, S.W.1. The latest date for th receipt of applications for the appointment i November 15.

A PRIZE of 300*l*. is offered by the Committee o the Christie Hospital, Manchester, for research o cancer. The object is to support research wor already in progress, and the competition is open t workers of any nationality qualified in medicine o in science cognate to medicine, but all papers sub mitted must be in the English language. Application must be received by the chairman of the Medica Board of the hospital on or before December 31.

A NUMBER of scientific works from the library o the late Sir William Crookes will be offered for sal by auction by Messrs. Hodgson and Co., 115 Chancery Lane, W.C.2, on Friday next, November 14, a 1 o'clock. The items include sets of the Chemica Society's Journal, *The Analyst*, the Journal of the Franklin Institute, the Journal of the Society o Chemical Industry, Phil. Trans. of the Royal Society 1863–1918, Catalogue of Scientific Papers (Roya Society), *Comptes rendus* of the Paris Academy o Sciences, 1864–1924, Revue Générale des Sciences, 1890–1924, etc. Catalogues are obtainable from the auctioneers.

AT the statutory meeting of the Royal Society of Edinburgh held on October 27, the following Officers and Council were elected: *President*, Sir James Alfred Ewing; *Vice-Presidents*, Principal J. C. Irvine, The Rt. Hon. Lord Salvesen, Prof. J. H. Ashworth, Prof. T. H. Beare, Dr. W. B. Blaikie, Sir Robert Blyth Greig; *General Secretary*, Prof. R. A. Sampson; *Secretaries to Ordinary Meetings*, Dr. Alexander Lauder, Prof. W. Wright Smith; *Treasurer*, Dr. James Currie; *Curator of Library and Museum*, Dr. A. Crichton Mitchell; *Councillors*, Prof. T. H. Bryce, Prof. J. Y. Simpson, Prof. D'Arcy W. Thompson, Sir James Walker, Prof. E. T. Whittaker, Prof. Henry Briggs, Mr. W. L. Calderwood, Prof. T. J. Jehu, Prof. C. G. Barkla, Prof. J. Graham Kerr, Lt.-Col. A. G. M'Kendrick, Mr. James Watt.

AT a General Meeting of the University of Durham Philosophical Society held on October 30 the following officers were elected:—*President*, the Chancellor of the University; *Vice-Presidents*, Sir Charles A. Parsons, Sir Theodore Morison, Prof. T. H. Havelock, Mr. Wilfred Hall, Prof. A. S. Ferguson, Dr. B. Millard Griffiths; *Secretaries*, Mr. J. W. Bullerwell and Dr. Grace C. Leitch; *Editor*, Dr. G. W. Todd; *Librarian*, Dr. F. Bradshaw; *Chairmen of Sections*, Mr. R. G. Lunnon (Chemical and Physical), Dr. Hickling (Geological and Biological), Mr. J. L. Burchnall (Mathematical), Dr. J. Wight Duff (Archæological), Mr. F. H. Alexander (Applied Science), Dr. A. Robinson (Philosophy); *Committee*, Dr. H. V. A. Briscoe, Commander Hawkes, Mr. S. H. Collins, Dr. G. R. Goldsbrough, Dr. J. A. Smythe, Mr. E. R. Thomas.

THE Gilbert White Fellowship has recently received a gift from the Earl of Dartmouth, four volumes of Journal for the years 1788, 1789, 1793, and 1794, with S. entries by the second Lord Dartmouth (1731–801) and some contemporary newspaper cuttings serted. The entries are in diary form and mainly eteorological and horticultural, with some records of lants, birds, and insect life. The localities from hich the observations date are Albury, Weymouth, astlehill, Whatcomb, Encombe, Carne, Henbury, ortland Place (London), Hayes (Kent), Maidenhead ridge, Tunbridge Wells, Walton-on-Thames, Brightelmstone (Brighton), Aylesford, and Grosvenor quare (London). About three-fourths of the entries re from Hayes, Kent. The association with Gilbert hite and his "Natural History of Selborne" is that is "Naturalist's Journal" was drawn up and has preface by White's correspondent, the Hon. Daines arrington.

IN the present year there occurs the tercentenary of he "Arithmetica Logarithmica," the first great work f Henry Briggs; the friend and coadjutor of Napier, nd the computer of the first table of common logaithms. In many senses the day of logarithmic tables to 4, 5, 6, or 7 figures is past. Where much computing has to be done, logarithms to a few figures are rarely used; what are used, and are often badly needed, are logarithms to 10, 15, or 20 figures. Recently the French have proposed to issue a 14 figure table and the Germans a 15 figure table. To celebrate worthily the tercentenary of Briggs's achievement, the Biometric Laboratory of University College, London, has arranged to issue "Logarithmetica Britannica," a standard table of logarithms of the 90000 integers of five digits, to 20 places of decimals. The necessary calculations are being undertaken by an able and enthusiastic computer, Mr. A. J. Thompson, of the General Register Office, Somerset House. It is to be published in nine parts by the Cambridge University Press, at the rate of about two parts a year, the first section (Part ix.) giving logarithms of integers from 90000 to 99999, together with their second and fourth differences, being now in the press. The success of the undertaking, which is not an enterprise of profit, can only be assured if a large section of the mathematical world shows readiness to commemorate with the producers of this work the tercentenary of the "Arithmetica Logarithmica."

Our Astronomical Column.

THE NOVEMBER METEORS.—Mr. W. F. Denning writes that this display may be expected to recur on he morning of November 15, but that it is not likely o be an abundant one. Meteors are evidently disributed along all parts of the elliptical stream, for ome of them are visible every year at mid-November. Occasionally there is quite a noteworthy shower, hough the parent comet (1866 I. Tempel) may be ear aphelion. The radiant point of the shower eing situated in the "sickle" of Leo, which does not ise until about 10.15 P.M., the meteors are invisible n the early hours of the evening. This year moonight will somewhat interfere with observation and overpower the fainter meteors. On clear evenings etween November 17 and 21, some of the Andromedids f Biela's comet may probably be seen.

A REMARKABLE PLANETARY NEBULA IN CASSIOPEIA.—Mr. J. H. Reynolds contributes an article to the *Observatory* for October on the nebula N.G.C. 7635, which was noted by Sir W. Herschel as containing an 8th magnitude star eccentrically placed. The article is illustrated by a photograph taken at Mt. Wilson by Prof. E. Hubble. It shows a slightly flattened ring 2′ 40″ by 2′ 15″, the interior of which is dark except for the southern third of its area, where it is strongly luminous. There is also some faint nebulous light outside the ring.

The star in the centre of the ring is very faint, about mag. 17; the star of mag. 8 mentioned above is about three-sevenths of the distance from centre to circumference. Its spectrum has been photographed at Mt. Wilson, being of type intermediate between O5 and the Wolf-Rayet stars. This spectrum makes the actual association of the star with the nebula more probable. Mr. Reynolds suggests that the illumination of the nebula may be due to its radiation, though its eccentric position is against its being the parent star of the nebula. He notes that if we assume the distance of the nebula as 20 parsecs (almost certainly a minimum estimate) its diameter is some 3000 astronomical units. (By an error, 9000 is given in the article.) He looks on these gas shells as marking the place of former novæ, and thinks that their duration is probably short.

MINOR PLANETS.—It seems most likely that the interesting object discovered by Dr. Baade on October 23 is a planet; its aspect is quite stellar, and its motion could be represented by an orbit not unlike that of Eros. Photographs were obtained at Greenwich on October 28 and 30, the magnitude being about 9·0. The arc of observation is still too short to deduce a trustworthy ellipse, but it appears that perihelion was passed about a month before discovery, and that the perihelion distance is somewhat less than that of Eros, which is 1·14. Prof. Kobold has computed the following parabolic orbit, presumably not with the idea that it is the real form of orbit, but in order to represent the motion for the next few weeks. On October 30 his computed place was right in declination, but 10 sec. too small in R.A.

$T = 1924$ Oct. 2·592 G.M.T.
$\omega = 134^\circ\ 17'$
$\Omega = 210\ \ 55$ } 1924·0
$i = 32\ \ 7$
$\log q = 0{\cdot}12463$.

EPHEMERIS FOR MIDNIGHT.

	R.A.	N. Decl.
Nov. 7	$22^h\ 17^m\ 24^s$	$5^\circ\ 59'$
11	22 35 0	3 53
15	22 52 0	2 3
19	23 8 28	0 32

The last two places have been deduced by extrapolation.

The motion is through Pegasus and Pisces. The meridian passage remains nearly stationary at about $7^h\ 15^m$, so that the object will be observable for some time.

Mr. B. M. Peek, while observing Nova Persei on October 27, detected a faint object very near it, which proved to be a minor planet. He communicated with Dr. W. H. Steavenson, who was able to observe it on the following night. If it had been new, it would have been the first visual discovery for many years, but Mr. G. Merton has established its identity with No. 709.

Research Items.

CEREMONIAL EXCHANGE IN EASTERN MELANESIA.—M. Raymond Lenoir, who has made a special study of the institution of north-west America termed, in his opinion improperly, *potlatch*, has published in *L'Anthropologie*, T. xxxiv. No. 5, an examination of the system of ceremonial exchange in the trobriands described by Dr. B. Malinowski in his "Argonauts of the Western Pacific," in the light of conclusions derived from a consideration of the evidence relating to similar customs not only from America, but also from the Asiatic Eskimo, the Chukchees, and the Melanesians of Bismarck Archipelago and the Solomons. Dr. Malinowski found that sea voyages, entailing a long and expensive communal preparation in accordance with a certain ritual, were undertaken with a view to the exchange of certain objects of wealth which were passed on by the recipients from island to island in an endless chain. This ceremonial he regarded as a phase of primitive economics. M. Lenoir, however, regards it as an institution which has grown out of a state of war, of which it is an attenuated form, and intended to preserve the relative status of different social groups. The maritime expedition is a raid in which the booty carried off by the victors or the gift received by them at the making of peace is represented by the ceremonial exchange of these objects. The conception of status applies to both forms of ceremonial exchange described by Dr. Malinowski, and the economic conception is accordingly a secondary or later development.

THE PRE-INCA AND INCA CULTURE OF PERU.—From 1899 until 1901, Dr. Max Uhle was commissioned by Mrs. Phoebe Hearst to conduct archæological excavations in Peru on behalf of the University of California, but owing to a variety of causes, no report on the excavations has been published. It has now been decided by the University to issue descriptions of the collections made by Dr. Uhle. The first of these has just been published as one of the Publications in American Archæology and Ethnology of the University. In it Messrs. A. L. Kroeber and W. D. Strong describe the collections from Chincha. The Chincha Valley was a peculiarly favourable site for archæological study as the Chincha Indians were one of the strongest and most famous tribes of Peru, and before the Incas became supreme, threatened to conquer all the interior of Southern Peru. Excavations were carried out at six main points in the Valley. The most important evidence which they produced, from the point of view of the sequence of culture and chronology, was the pottery; but the conclusions to which this points are supported by the other antiquities. These included shells and beads, textile apparatus and textiles, and objects of metal, as well as human remains. The cultural periods distinguishable are Inca, with which were associated beads of blue glass of European origin, and possibly two pre-Inca periods, Late Chincha I. and Late Chincha II., the latter being perhaps a phase of transition with which the Inca overlaps. There are also some indications of a proto-Chincha period in the form of objects of shell and ivory as well as fragments of pottery which suggest the Nasca or proto-Nasca style. The chronology suggested is for the Inca period *c.* 1425, for Late Chincha II. about a century earlier, and for Late Chincha I. from about 1000 or 1100.

THE GOAL OF COMMERCE.—Mr. G. G. Chisholm, in the Herbertson memorial lecture, published in the summer issue of the *Geographical Teacher*, says that the goal of commerce "is that stage in the evolution of commerce when the inhabitants of the earth wi be able to enjoy the greatest possible variety c commodities supplied at the least cost and with th greatest attainable stability of prices." This is definition with which few will wish to quarrel. Ther may be dissentients, however, when Mr. Chisholr goes on to say that the only condition of reachin that goal on which it is necessary to lay stress i the completion of all the main lines required in th network of communications. In fact, he himsel proceeds to point out that there are other importan factors besides lack of communications which stan in the way that leads to this goal. He instances th excessive density of population in Far Eastern regions The low wages arising from over-population in certai lands react, he points out, on industries in othe countries by bringing about excessive competition o one hand, as in the case of India and Lancashire in th cotton trade, and on the other, by restricting the pur chasing power of the people and therefore the marke which those lands might afford. After many reference to writings on the subject of over-population, Mr Chisholm contributes the suggestion that the bes solution of the problem of how to reach the goa of commerce is "to raise the standard among th poorer classes of the coloured peoples as quickly a possible to the level of the whites, so far as that ca be done." He does not develop his suggestion o touch on the problem as to how the increase o wages of the peoples, who at present have a lo standard of living according to Western ideas, ca be prevented from leading to a serious rise in th price of raw materials (such as cotton, jute, rubber and of foodstuffs (such as oil-seeds, coffee, cocoa tea, and so forth), as to lower appreciably the standard of living of the peoples of the industrial regions o the world. In an article in the *Times* of October 1 attention is directed to the enormous increase of th consumption of wheaten flour in the Far East. Vancouver, which exported only about half a million bushels of wheat in the year ending March 1921, exported forty-one and a half million bushels in the year ending March 1924! This went mainly to Japan and China. At the same time the price of wheat in Great Britain, which rarely before the War exceeded 35*s.* per quarter, has this month risen to more than 70*s.*! This article affords a very interesting comment on the problem in question.

TSETSE-FLY INVESTIGATIONS IN NIGERIA.—The *Bulletin of Entomological Research*, vol. xv., August 1924, contains a paper by Drs. L. Lloyd, W. B. Johnston, W. A. Young, and H. Morrison, on tsetse-fly investigations in the northern provinces of Nigeria. This work contains a record of the trypanosome infections, food, and breeding of *Glossina morsitans* and *G. tachinoides*, obtained by examining these flies at various foci over a period of fourteen months. It confirms the fact that the breeding of both species is practically confined to the dry season, and follows a period of increased food supply. The tsetse-fly, *Glossina morsitans*, does not feed on reptilian blood, but in times of hunger draws some of its food from birds: in the locality under consideration it resorts mainly to small antelope, big game being scarce. *G. tachinoides* is less restricted in its diet, and in the wet season one-fifth of its food was drawn from a group of animals which included man, monkey, and dog. The infection of the flies with *Trypanosoma vivax* and *T. congolense* bears a close relation to the amount of blood obtained from antelope, and consequently *G. morsitans* is in general nearly four times as heavily infected as *G. tachinoides*. Infections with

T. brucei and *T. gambiense* are scarce in this locality. Trypanosome infection rises just before the main breeding season in *G. morsitans* in all localities, and in *G. tachinoides* in places where the fly is largely a nimmal feeder. The proportional infection in general falls in the season of most rapid breeding, owing to the masking of the actual rise by the number of young flies examined. It rises rapidly when breeding ceases. The total infection is reduced when fly-food is hard to obtain, in the time of long grass and flood, owing to *T. vivax* infections dying out when the flies are starved. There is just an indication that postponement of grass burning may interfere with the free breeding of *G. morsitans*, and in some cases that of *G. tachinoides*. This possibility is to be tested. The experiment of excluding game and fly from one of the dry season foci of the flies by means of fencing will be carried out.

DISTINCTION OF THE TWO DRUGS, *HELLEBORUS NIGER* AND *H. VIRIDIS*.—Mr. T. E. Wallis and Miss Alison M. Saunders have carried out a useful if somewhat negative service to pharmaceutical knowledge by their careful anatomical investigation of the rhizomes and roots of *Helleborus niger* L. and *H. viridis*, upon which they report in *The Pharmaceutical Journal and Pharmacist* for July 26, 1924. These parts of both plants are employed as drugs, and various writers have described anatomical criteria in these organs by which the two species may be distinguished. The result of thorough examination of a wide range of specimens is to negative the validity of all such suggestions, and the authors recall an earlier suggestion of Hartwich that the rhizomes should be collected with the basal leaves attached, as these are trustworthy means of determining the two species.

A MILDEW DISEASE OF THE "WILD HOP."—A brief note by Messrs. E. S. Salmon and W. M. Ware in the *Gardeners' Chronicle* for October 18 records the finding of *Peronoplasmopora humuli* on "wild" hops in the hedgerows of Kent and Middlesex. Until now this fungus, first described by Japanese workers as occurring in that country, has been little noticed in Great Britain, since it was found by the writers on cultivated hops in the Experimental Hop Garden at Wye in 1920, when it was assumed to be an introduction from America or Japan, introduced with the hop plants. This is still perhaps the explanation of its occurrence here, as if it had been long at home upon the "wild" hop of the south of England, itself usually an escape from the hop of cultivation, it would surely have more frequently been reported from the cultivated hop-field. Messrs. Salmon and Ware note its striking resemblance to the mildew on nettle, *Peronospora urticæ*, and are apparently engaged in further investigation before deciding that these two mildews are not the same species.

A LOWER CRETACEOUS FERN.—Prof. Seward describes an exceptionally well-preserved specimen of the genus Tempskya, a fern characteristic of certain Lower Cretaceous Floras, in the *Annals of Botany*, Vol. 38, No. 151, July 1924. He names the specimen provisionally *T. Knowltoni* (anatomical characters of stem, root, and petiole alone scarcely providing the material for a final placing of the plant), after Dr. F. H. Knowlton of the U.S. Geological Survey, from whom he received the specimen and who reports that its probable source is the Kootanie formation of Montana. Tempskya was a fern of somewhat unusual habit, a mass of slender dichotomously branching stems, some of the branches bearing thickly clustered petioles, and all growing within a thick tangle of interlacing roots, forming together a kind of "false stem," which as a whole in some cases had a definitely dorsi-ventral habit. The stem contains a solenostelic vascular system, and Prof. Seward concludes that the examination of the present specimen supports his previous decision, based on material examined earlier, that this fossil fern has affinities with the modern Schizeaceæ.

JURASSIC AMMONITES OF INDIA.—Dr. L. F. Spath (*Palæont. Indica*, N.S., ix., No. 1, 1924) gives a revision of the ammonites from Kachh based on the collection of J. F. Blake, now in the British Museum, and introduces many new generic names. The species are mainly of Upper Jurassic age, ranging from Callovian to Kimeridgian, but a few are referred to the Aptian. The author considers that the widespread simplification of suture-lines in post-Triassic ammonites has not been fully appreciated, and suggests that the natural order of Jurassic ammonites may well be from complex to simple. The "families" considered are regarded as morphological rather than genetic units, and their relationship to the long-lived and fundamental families Phylloceratidæ and Lytoceratidæ will be considered later.

ROSE QUARTZ.—The cause of the colour in rose quartz has been very thoroughly investigated by E. F. Holden, and his conclusions are published in the *American Mineralogist*, vol. 9, April and May, 1924. Rose quartz is always massive. Occasionally pink crystals occur, but their colour is due to the presence of hæmatite inclusions. The effect of radium radiations on white or rose quartz is invariably to produce a dark smoky colour, and it is interesting to notice that smoky quartz is a constant associate of radioactive minerals in Madagascar and Ontario, whereas rose quartz is not. Careful analyses show that the rose colour cannot be due to titanium or iron, which are in all cases accounted for by the presence of rutile inclusions and limonitic stains respectively. Manganese, however, varies regularly with the depth of the tint; the absorption spectrum agrees with that of trivalent manganese glasses and solutions; and the pleochroism is exactly like that of other minerals which owe their colour to the presence of trivalent manganese compounds. The colour can, moreover, be closely imitated by dissolving less than 0·01 per cent. of manganese in a silica gel, and in this case, as in actual rose quartz, the colour disappears on heating to the transition temperature of 575° C. The convergence of evidence is therefore completely in favour of the conclusion that rose quartz owes its tint to the presence of trivalent manganese. In a former paper (*Am. Min.*, vol. 8, July 1923) the same author showed that the colour of citrine, like that of colloidal solutions of ferric hydrate, is due to sub-microscopic particles of hydrous ferric oxide.

THE VAPOUR PRESSURE OF CARBON AT HIGH TEMPERATURES.—In an investigation of the carbon arc light, Messrs. H. Kohn and M. Guckel have measured photometrically the brightness of the crater surface, using different kinds of nearly pure carbons and graphite, with different currents, and pressures varying from 5 to 0·06 atmospheres, the gases employed being air, argon, nitrogen, and carbon dioxide (*Zeitschrift für Physik*, September 17). Above a certain input the surface brightness, and therefore the temperature of the positive crater, reaches a maximum value, which does not increase with increase of current; this constancy has been observed at atmospheric pressure, from 0·3 to 2·1 amp. per sq. mm.

The maximum temperature was the same at the same pressure for the different carbons, and the different gases in which they were used. The ionisation in the arc, on the other hand, depended on the gas; the difference between the anode fall in air and argon was about 50 per cent. The equilibrium temperature of the crater is thus independent of the chemical and electrical processes in the arc, and probably depends, as Lummer has already indicated, on a thermodynamical equilibrium, the evaporation equilibrium of carbon. The pressure equilibrium-temperature curves are identical over the whole range for all four gases; from 5 to 0·8 atmospheres they can be represented by the Clausius Clapeyron equation, and so can be regarded as the vapour pressure curves of carbon, confirming the preliminary results of Fajans and of Kohn. The probable value of the heat of vaporisation of graphite, at room temperature, is deduced as $\lambda = 139{\cdot}2$ k. cal.; this value may be 7 per cent. too high or too low. The value deduced from the theoretical chemical constants, assuming the vapour to be monatomic, is 141·4.

THE EFFECT OF OXIDISERS ON SENSITIVENESS AND ON THE DEVELOPABLE IMAGE.—In the October number of the Journal of the Franklin Institute is a communication on this subject by Messrs. S. E. Sheppard, E. P. Wightman, and A. P. H. Trivelli, of the Eastman Kodak Company. After a concise summary of the results of recent work, the authors say that it appears from these and other facts that the development centres are latent image spots "which apparently consist of colloidal silver, and that these in turn proceed from pre-exposure sensitive spots in the grain, which may also consist of silver specks, possibly only a few atoms in magnitude." Previous work has shown that the treatment of an ordinary plate with copper sulphate solution merely lowered the sensitiveness of the plate, shifting the H. and D. curve to the right. But the authors find that if the emulsion is diluted so that there is only one layer of silver-salt grains, the copper sulphate treatment causes a marked increase of the steepness of the H. and D. curve, the maximum density being little if at all affected. This matter is being further investigated. When plates are treated with chromic acid the sensitiveness is rapidly reduced and gradually approaches a constant value. The authors have tried the effect of chromic acid on the developable image, and find that it is very considerably destroyed, the slope of the H. and D. curve is much reduced, but that after even many hours' treatment, the last traces of the developable image are not removed. Permanganate appears to be more active in its destruction of sensitiveness than chromic acid, and the authors are investigating its action on sensitiveness and on the developable image.

RESEARCH ON INDIAN TIMBERS.—An account of the research work being carried out on Indian timbers at the Forest Research Institute, Dehra Dun, India, appears in the *Chemical Age* for October 11, 1924. The most important section of the work deals with timber seasoning, experimental kilns with complete mechanical equipment having recently been erected. Wood preservation is also receiving attention; several of the Indian railway companies are installing plants for treating sleepers. Sleepers treated with the oil Avenarius Carbolineum have been found to show no signs of decay after being in the ground for two years. During the past year, 11,000 timber tests have been carried out. An experimental paper-pulp plant is now working, and an exhaustive inquiry into the tan-stuffs of the mangrove forests (Lower Burma) h just been completed.

THERMAL ACTIVATION BY COLLISION.—In the Jou nal of the Chemical Society for September, Hinsh wood and Hughes describe experiments on the therm decomposition of chlorine monoxide. The reacti appears to be complicated by intermediate produc but an average value of the velocity constant w found. From this the number of molecules reacti per second is calculated. The ratio of this to t number entering into collision per second (in bo cases per c.c.) gives the fraction of effective collisio Pfaundler (whose name does not appear to be me tioned) about forty years ago suggested that on collisions between molecules having a certain exce of energy above the mean value are effective, ar if Q is the excess energy, Maxwell's result sho that the ratio mentioned can be equated to $e^{-Q/R}$ The value of Q is found to be 22,000 cal. E plotting log $(1/t)$, where t is the time for a give fractional decomposition, against 1/T, a value of th "heat of activation" is found in the usual way t be 21,000 cal., and the conclusion is reached that th agreement seems "to render it certain that bimol cular reactions can be interpreted in terms of simp thermal activation by collision," without recourse t the radiation theory.

DESTRUCTIVE DISTILLATION OF COAL.—The Journa of the Royal Society of Arts for September 26 an October 3 and 10 contains a report of Cantor Lecture by Mr. E. V. Evans, chief chemist of the Sout Metropolitan Gas Company, on this subject. A give number of therms available as raw coal can be dis tributed among gas, tar and coke in a variety o ways, depending on the type of carbonisation pro cess adopted and the conditions of its operation. A diagram is given showing the distributions in hig temperature carbonisation and in low temperatur carbonisation. The yield of therms as gas in th former is more than double that in the latter, less ta is obtained, and less volatile matter is left in the cok as compared with low temperature carbonisation There is practically no difference between volatil therms and coke therms in the two processes if th volatile part in the coke is taken into account. Th difference is merely one of distribution. The rate o carbonisation is shown by diagrams. A very larg volume of gas of high calorific value is evolved in th first ten minutes after closing the door of the retort in this period 5 per cent. of the total gaseous therm is produced. In the second lecture the very clos relationship existing between gas and tar was fully considered. Laboratory experiments show that th total volatile therms (gas and tar) decrease gradually as the rate of carbonisation becomes slower, there being a very marked decrease in the case of exceedingly slow carbonisation, and the ratio of gas to tar therms decreases considerably with reduction in the rate of carbonisation. The results are interpreted by tar cracking. The belief that the rapid heating o coal is very wasteful of thermal energy is mistaken. The physical conditions obtaining in the retort were explained in the third lecture, which concluded with an account of a process for producing briquettes from a mixture of coal and coke. This is considered more promising for the manufacture of smokeless fuel than low temperature carbonisation. By mixing inert material such as coke with the original coal, a rapid rate of heat transmission is attained which results in enhanced yields of volatile therms. Such an innovation in the carbonising process opens up new possibilities in the development of the gas industry.

The International Union of Geodesy and Geophysics.

THE International Union of Geodesy and Geophysics held its second meeting at Madrid on October 1-8, at the invitation of the Spanish Government. Out of the twenty-seven countries which now belong to the Union, twenty-five were represented at Madrid, and the total number of delegates who attended amounted to one hundred and fifty.

The scientific work of the conference was carried on in the seven Sections into which the Union is divided, namely, Geodesy, Seismology, Meteorology, Terrestrial Magnetism, Oceanography, Volcanology, and Hydrology, and in each of these the time available was barely sufficient for the adequate discussion of all the reports and communications which were presented.

The Section of Geodesy commenced its meetings four days before the formal opening of the conference, and even then found the time at its disposal too short. Its meetings were very well attended, there being usually about fifty members present, and a large amount of very useful work was accomplished.

In each Section, reports were received of the work done in various countries during recent years, and especially since the last meeting of the Union in Rome in 1922; proposals sent in by the different national committees were discussed; and joint meetings were held with other Sections to investigate matters of common interest.

At the meeting in Rome the Swiss representatives had proposed that the Union should recommend the adoption by countries newly taking up geodetic work, or where new work admitted of it, of an international ellipsoid of reference. This gave rise to a very full and interesting discussion, and finally the executive committee's recommendation to employ in such cases Hayford's ellipsoid of 1909 was agreed to, although an alternative proposal to use an "arbitrary ellipsoid" differing but slightly from Hayford's obtained a considerable measure of support. The importance of carrying out geodetic work in the southern hemisphere, of such a standard that it could be used in the determination of the earth's figure, was strongly urged, and Australia was suggested as an area where such work could very advantageously be undertaken. A committee was appointed to take such steps as might be necessary to advance the completion of an arc of meridian from the Arctic Ocean to the Mediterranean.

In the Section of Seismology, a very instructive report on the recent Japanese earthquake was presented by the Japanese delegates, and was fully discussed. The Section decided to continue the publication of the International Seismological Summary at Oxford, and also of the seismological memoirs which are published from time to time at Strasbourg.

The Section of Meteorology re-elected Sir Napier Shaw as its president for another period. A number of interesting reports were received, and joint meetings were held with the Section of Oceanography on marine meteorology, and with the Section of Hydrology on their relative spheres of activity and on the measurement of rainfall data. The Section decided to continue investigations in the next few years into the physical conditions in the upper air, and to extend them to altitudes above those usually reached by "ballons-sonde"; also, to proceed with research on the subject of solar radiation.

The Section of Terrestrial Magnetism had a long programme which provided many useful discussions on the procedure of observatory work, the measurement and interpretation of records, and the design of instruments. The extension of magnetic surveys to areas not yet surveyed, and especially in high northern latitudes, was strongly advocated. In the next few years the Section decided to direct its attention to the international comparison of instruments, the magnetic and electrical characterisation of days, and to certain special investigations for which instruments will have to be designed.

Prof. Odon de Buén, of Madrid, was elected president of the Section of Oceanography in succession to the late Prince of Monaco. Much attention was given to echo-sounding, and also to tidal phenomena. In the latter subject, a joint meeting was held with the Section of Geodesy to discuss the subject of earth-tides. A committee was appointed to arrange for co-operation with the International Association for the Exploration of the Sea and the avoidance of duplication of effort.

The subject of the changes of level and of gradient in the vicinity of volcanoes was discussed at a joint meeting of the Sections of Volcanology and Seismology; and in the former the geothermal gradient and the thermal constants of rocks occupied the attention of the members at its meetings. The bureau of the Section is at present at the Vesuvius Observatory, but it is hoped that the University of Naples may offer it accommodation, which would be a more satisfactory arrangement.

The Section of Hydrology was formed only at the Rome meeting, so that much of its time was occupied with questions of organisation. A proposal that it should amalgamate with the Section of Meteorology was considered, but was not adopted. In the special work of the Section, a valuable report on the gauging of the Nile discharge was presented from Egypt; the statistical methods in use in Italy in such work were explained; and a very interesting report came from France, which dealt with the prevision of floods and with the estimation of hydro-electric potentialities. The extension of the Section's work to the phenomena of glaciers and the avoidance of encroaching on the work of existing organisations was considered and a satisfactory solution was reached.

At the final meeting, the invitation of the Republic of Czechoslovakia to hold the next meeting of the Union in Prague in 1927 was accepted. Col. H. G. Lyons was elected general secretary of the Union for a further period.

The Spanish Government extended the most ample hospitality to the delegates. The Chamber of Deputies, not being in use at the time, was available for the meetings. H.M. the King of Spain presided at the opening meeting, and later a reception was held at the palace by their Majesties the King and Queen, to which all the delegates were invited. The arrangements for the meeting and for the various visits to museums, scientific institutions, etc., which were made by the National Committee and were in the hands of Señor D. Cubillo and Señor D. Galbis, were extremely well planned and worked without the least hitch throughout. After the close of the meeting, many of the delegates availed themselves of the excursions which the committee had arranged to Andalusia and to the eastern provinces, where they were shown the scientific institutions and the objects of special interest at the various places.

The technical communications received by the Sections will be published by them in due course in their reports of the meeting.

Ecology of Moorland Plants.

OTTO STOCKER, of Bremerhaven, has a very interesting review of the recent work by Montfort and himself upon this problem in *Die Naturwissenschaften* for August 8. The problem is an old one. Plants of the heath and of moorland, such as Calluna and Erica, have a form and structure that suggested to some of the earlier workers, and notably to Schimper, that they must be adapted to reduce water-loss arising from transpiration. Schimper advocated this view in his classical book upon "Plant Geography," and, faced with the problem that moors are by no means dry places, influenced probably also by his earlier studies of the mangrove swamps bordering salt water lagoons, he escaped from the difficulty by the assumption that these moorland soils must be "physiologically dry." This view of the xerophytic character of moor vegetation has been handed on from text-book to text-book, although it is based almost entirely upon the appearance of the vegetation and is unsupported by experimental evidence, apart from certain American experiments which showed that extracts of bog soils were toxic to certain non-ericoid mesophytes under certain experimental conditions.

Now Montfort has shown by direct experiment that the water of moorland soils is not toxic to moorland plants, and he also concludes by the way in which these plants still release water from cut stems, or exude it in drops from the leaves (guttation), that the moorland water in no way diminishes the absorption of water by the root system or its active pumping upwards into the shoot. Furthermore, by measurements of transpiration as well as of water absorption, Montfort showed that these processes went on freely in all plants grown in normal moorland water, though some extracts of soils in which secondary decompositions were proceeding might prove toxic to plants and reduce water absorption and transpiration as well as every other normal activity of the plant.

"Physiological dryness" seems, then, to be a myth; under the examination of Stocker there is not much left of the case for the xerophytic character of Calluna and the ericoid shoot. It is true that the single leaf of the ericoid plant may be interpreted as xeromorphic in structure, but a calculation of the total leaf surface per unit of root system puts Calluna ahead of many mesophytes in its proportion of transpiration surface, and an examination of the amount of transpiration of the plant as compared with its root absorbing system shows Calluna to be better classed as a "xeromorphic mesophyte," able to lose water like a mesophyte because in its natural habitat plenty of water is practically always available. Stocker has his own teleological explanation to replace the one he has so decisively disposed of. He suggests that the special ericoid type of leaf has its advantage on the wind-swept moor as a type that prevents the marginal withering effect produced by drying winds.

It may be pointed out, however, that exactly the same criticism can be brought against this view of Stocker's that he levels against the view of Schimper, namely, that it lacks experimental basis. His next suggestion, that this type of vegetation dominates the moors because its high rate of transpiration enables it to accumulate large quantities of salts from the relatively dilute salt solution of the moor, certainly seems to rest upon a fundamental fallacy, which again has often crept into the text-books. The salts in the soil are not drawn in with a current of water rushing into open pipes and then concentrated by the evaporation of this solution at the leaf surface. The water itself enters, diffusing across a protoplasmic membrane in accordance with the osmotic gradient, and this condition determines the entry of water alone a not of the salts with it. If the salts enter, they their turn will diffuse inwards according to th relative concentration within and without the pla and therefore their rate of entry will only be indirec affected by the rate of transpiration, and this proc is not likely to influence greatly the amount of s collected in the plant.

This conclusion, the only one possible from physico-chemical point of view, has now an expe mental basis in the work of Muenscher (*Americ Journal of Botany*, vol. 9, pp. 311-329, 1922). Whil then, Stocker disposes effectually of the present tele logical explanation of the characteristic ericoid type leaf, he is not very happy in the similar type of explan tion that he puts forward himself. But it may be ask —is it necessary to put forward any theory of this ty to account for the characteristic heath and moorla vegetation? The writer has recently approached t subject from another point of view in two brief pape with Miss Hinchliff, published in the *Naturalist* (192 pp. 263-268, and 1924, pp. 201-209).

Dr. F. E. Clements, Associate in Ecology of t Carnegie Institution, has recently shown in his mon graph upon "Aeration and Air Content," published b the Carnegie Institution, that one of the governi factors in the peaty soil of the moorland and the heath the lack of proper aeration in this soil, which renders unsuitable for the growth of the root system of normal plant. The present writer has pointed o that the metabolism of the root system of differe plants may be expected to differ, and that some plan may require less oxygen for their growth; that t plants on peat are perhaps such plants, and tha associated with this peculiarity they have anothe namely, that they form unusually large quantities fat in the roots as they grow. These fatty substanc are then sent up into the shoot and accumulate fir at the surface of the shoot as an early and abnormall thick cuticle, and then within the shoot again in earl deposits of secondary endodermis and then of cor layers within that endodermis. It is pointed out tha these fatty deposits are responsible for certain stru tural changes, and a later paper (Beatrice Lee an J. H. Priestley, "The Structure, Occurrence an Distribution of the Cuticle," *Annals of Botany*, Jul 1924) has strengthened the conviction that a thic cuticle deposited at an early stage will profoundl modify the structure of the young shoot and of th leaves upon which it is deposited.

This developmental factor may in the end prove t have a great deal of influence upon the characteristi form and structure of the plants growing on the peat In this case their characteristic habit is not traced t an adaptation to control water loss, but is found t be a natural developmental consequence of the char acteristic metabolism of a root system growing in a soil that lacks sufficient aeration. Wherever the peat plants grow, whether in peat or in other soils, they will retain this characteristic metabolism, accumulate fats, and show the same characteristic structure But in peat soils they reign supreme because other plants which do not have this metabolism fail t grow there. One further interesting point about this view is the light it throws upon the unsuitability of many of these peat plants to soils that are rich in calcium, calcium salts producing very insoluble soaps with fatty acids, so that in a soil rich in calcium the fatty acids, instead of passing upwards to the shoot, accumulate in the root system and plug it up until its normal functions are carried out with difficulty.

J. H. PRIESTLEY.

High-Speed Tool Steel.

NEARLY a quarter of a century has elapsed since a revolution in metal-machining practice was used by the invention of the so-called high-speed tting tools by Messrs. Taylor and White, of the ethlehem Steel Company, U.S.A. This discovery as not an isolated one but was simply the last of a ries of connected discoveries leading to this parti- lar result. To a large extent it was empirical and advance of the metallurgical theories of the time. gave rise to various researches designed to explain ie remarkable properties of these steels. Most of ese have thrown some light on the properties in uestion, but none of them can be said to have provided complete explanation of all the phenomena observed. he paper, therefore, by Messrs. Marcus A. Grossmann nd Edgar C. Bain "On the Nature of High Speed teel," presented at the autumn meeting of the Iron nd Steel Institute, is to be welcomed in that it con- itutes a further attempt to place on a scientific undation a comprehensive theory of the mode of ction of these steels.

The paper gives an account of the physical pheno- ena occurring from the time of casting the homo- eneous melt to the production of the hardened ols. The authors emphasise the point that high- peed steel, far from being an alloy having wholly nique properties, merely possesses to an unusually harked degree certain of the tendencies which may lready be discerned in other steels and alloys. They ave availed themselves of the results of many of the ethods of investigation applicable to metals, and the nore recently developed conceptions of crystal struc- ure and hardness constitute the foundation upon which the views offered have been built. They onsider high-speed tool steel essentially as a binary lloy, of which one constituent is a solid solution of hromium in iron and the other the complex carbide ontaining tungsten, chromium, vanadium, and carbon. n the unhardened condition the finished bar is re- garded as containing on an average 30 per cent. of arbide, but this is not evenly distributed. Rather nore than half of it is in the form of fine particles which have been precipitated from solid solution, and, owing to "coring" in the original dendrites, it is never completely removed. There is a concentration gradient from the centres to the edges of the crystals. The remainder of the carbide is in comparatively coarse particles, which represent the plates of carbide in the original eutectic. These are still present in fairly pronounced streaks throughout the piece.

When this aggregate is heated to the hardening temperature (about 1300° C), the solubility of the carbide in the γ iron increases rapidly as the tempera- ture rises, so that at the highest temperature nearly half the total carbide can be dissolved in the matrix. Owing, however, to the sluggishness of diffusion of the alloying elements, especially the tungsten, the amount dissolved never reaches the theoretical figure, and the austenite formed is far from homogeneous. In addition, small regional concentration gradients are set up round the larger carbide particles, the solution of which is never complete. Incident- ally, the particles of excess carbide exercise a very useful function in preventing grain growth at this high temperature, which would otherwise be so rapid as to render the steel useless on account of brittleness.

After being suitably heated, the steel is now quenched, and in this process a portion of the austenite is transformed into martensite, so that freshly quenched high-speed steel shows under a microscope grains consisting of a mixture of austenite and marten- site, and distributed through them the excess carbide particles. A light etching reveals the austenite grains and the excess carbide particles, but suitable further etching shows the martensite quite clearly. The relative proportions of martensite and preserved austenite undoubtedly vary from place to place. The regions lower in carbide contain more martensite, while those richer in carbide contain more austenite.

A piece of freshly quenched steel is thus to be con- ceived as containing regions of austenite-martensite mixtures of widely varying stability. On heating at comparatively low temperatures, softening is con- sidered to take place in the martensitic areas, and this low-alloy martensite resembles carbon steel martensite. The decomposition of this can be traced both in changes of hardness and of shrinkage. On heating to 600° C. the phenomenon of secondary hardness is observed, due to the conversion of the austenite regions to martensite or troostite. This reaction takes place throughout the tool. The total effective hardening may be considered, therefore, as representing the algebraical sum of hardening effect of the transformation of the various austenites and the softening of the various martensites.

The authors do well to emphasise the point that "secondary hardness" is by no means restricted to high-speed steel and that it is not the same as "red hardness." The retention of austenite on quenching is characteristic of many alloy steels on heating to sufficiently high temperatures. When this is reheated at low temperatures, secondary hardening sets in owing to the formation of minute crystals of α iron and the precipitation of fine carbide particles. Indeed, it is likely that if the tungsten of high-speed steel were omitted altogether, the remaining elements alone would be sufficient to cause the retention of the aus- tenite and the appearance of secondary hardening. The special usefulness of high-speed steel, however, is due to the extent to which it exhibits the property of red hardness, and it is here that tungsten plays its rôle. The large, heavy, immobile atoms of this metal act by supporting the structure at these slightly elevated temperatures and prevent the diffusion and agglomeration of the carbide particles, which would otherwise take place with consequent softening.

H. C. H. C.

Isotopes and Spectra.

THE question of the spectroscopic evidence of the existence of isotopes, which has already been brought forward in our correspondence columns (see NATURE, March 29, May 31, August 16) is dealt with at length in two papers published in the *Japanese Journal of Physics*, vol. ii., Nos. 6-10,—the first by Nagaoka, Sugiura, and Mishima, on "The Fine Struc- ture of Mercury Lines and the Isotopes," and the second by Nagaoka and Sugiura, on "Spectroscopic Evidence of Isotopy."

The assumption is made that the mercury atom consists of a central mass with a proton quasi-elas- tically connected with it. Vibrations of this system are conceived to give rise to spectrum lines. Thus, several mercury lines are known to have large numbers of closely adjacent satellites. It is thought that these are due to coupled vibrations of the nucleus owing to the stimulus given by the principal line which seems to be excited by the change of electron configuration according to Bohr's scheme. A number of facts are

adduced in support of the hypothesis. It is possible to calculate the intervals between the lines which would be produced by the vibrations of such a nucleus. Knowing the masses of the main core and the proton, and taking these from the observed values of Aston for the isotopes of mercury, the calculated intervals are shown to be in good agreement with the intervals between the satellites of mercury lines. The latter were carefully measured by the use of crossed Lummer-Gehrcke plates, and a discussion is introduced on the forms of the interference points so produced. It is concluded that the fine structure of mercury lines is due to the existence of several isotopes.

In the second paper the more general hypothesis is advanced that non-series lines in spectra are produced in an essentially different manner from the series lines. The latter are adequately accounted for by the movements of satellite electrons, according to Bohr's model, but the non-series lines are assumed to arise from the vibrations of pairs of atoms coupled in the manner described above for the mercury nucleus and its associated proton. When an element has two or more isotopes, two kinds of coupling are possible—symmetric and asymmetric—corresponding to pairs of atoms having the same and different masses respectively. A formula is given for calculating the wave-length intervals between lines arising from the coupled atoms, and these are shown to be in good agreement with intervals found in the spectra of elements the isotopes of which are known.

The lines having these intervals are accordingly looked upon as products of atomic vibrations and not of passages of an electron from orbit to orbit. Most of the lines so explained are spark lines. They are remarkably numerous in the spectra of the monatomic gases; thus, more than 90 per cent. of the 856 neon lines given by Paschen are assigned to atomic vibrations, and in argon a still greater proportion. An explanation of this is given. It is concluded that atomic vibrations give rise to spectra having constant frequency differences, and the suggestion is made that unknown isotopes may be detected from spectroscopic data.

Problems of Unemployment Insurance.

AT the recent Toronto meeting of the British Association, a paper by Prof. John R. Commons, of the University of Wisconsin, on "The Limits of Unemployment Insurance," was read to the Section of Economic Science and Statistics. In view of recent discussion in Great Britain of the relative merits and demerits of insurance by industry, insurance by firms, and the present State system, a short account of this paper may be of interest.

Prof. Commons is a well-known advocate of unemployment insurance in the United States. Conditions in the States are, of course, very different from those prevailing in Britain, and in particular there is a strong prejudice against a State insurance scheme. Prof. Commons in his paper emphasised the point that the principle of overhead charges (*i.e.* those manufacturing costs that go on whatever the number of units produced) applies to labour just as much as to capital, though this fact is not generally realised by industrial firms.

The modern manufacturer is faced with problems of business cycles, overhead costs, and organised labour that were unknown to his predecessors of the time when Adam Smith wrote, or perhaps more correctly it would be truer to say that nowadays these problems are greatly intensified. Business cycles are "a normal abnormality of the nineteenth and twentieth centuries."

The business cycle results in a lag both in time and amplitude in the daily wages received by labour compared with the prices obtained for the product by the employers. Organised labour, however, tends to reduce this lag by boosting wages during the rise and holding them up during the slump. Consequently, such labour obtains a higher *daily* wage while employed, on account of the business cycle than would otherwise be the case.

Two solutions of the problem are apparent, either (1) the curve of employment or (2) that of daily wages must be smoothed out. If attention be concentrated on the first solution rather than on the second, the community of interest rather than the antagonism of interest between capital and labour becomes clearer.

Statistics, however, point to a curious paradox, for large firms show greater fluctuations in their labour demands than the smaller. This is not what might have been expected, since the large firm has presumably a much larger item of overhead relative to the number of employees, which would at first sight seem to intensify the inducement to make greater efforts to stabilise production, thus reducing the overhead costs per unit of product. Apparently in practice the large firms take care of their capital overhead by means of high profits at the peak and large reserves for the trough of the business cycle, compelling their employees to take care of the labour overhead on a slumping market. If the employment cycle is to be smoothed out, the principle indicated from this analysis is that industry should take care of both kinds of overhead. The only way, however, to induce industry to take care of this labour overhead charge is "through the pocket book."

Prof. Commons arrives ultimately at three propositions:

(1) The larger establishments should each carry, so far as possible, its own risk by way of setting aside its own reserve, not merged with the reserves of other establishments in a common fund.

(2) Establishments having a small number of employees should be treated differently from those with a larger number. They might, for example, be organised in the form of a mutual insurance scheme.

(3) Employees should not ordinarily be required to contribute to the fund out of their wages.

"It will be seen," concludes Prof. Commons, "that only from the largest establishments and not from the smaller establishments, nor from the employees nor from the State, can any material progress be made towards prevention of unemployment."

University and Educational Intelligence.

BELFAST.—Applications are invited for two posts in the Queen's University, namely, the professorship in bio-chemistry and the lectureship in bacteriology. Terms of the appointments are obtainable from the secretary of the college.

BRISTOL.—Prof. Andrew Robertson, professor of mining and mechanical engineering in the Merchant Venturers Technical College, has been appointed principal of the College in succession to the late Dr. Wertheimer.

CAMBRIDGE.—T. R. B. Sanders, Trinity College, has been elected to a fellowship at Corpus Christi College. A. M. Binnie, Queens' College, has been awarded the John Winbolt Prize in engineering. The number of freshmen who have matriculated this term is 1498. The corresponding figure in 1913 was 1110.

LEEDS.—The council of the University has appointed Dr. F. S. Fowweather to the lectureship in chemical pathology recently instituted. Dr. Fowweather graduated with First-Class Honours in chemistry (1st Division) at the University of Liverpool in 1914. Later he took up the study of medicine and graduated M.B., Ch.B., at Liverpool in 1922, afterwards obtaining the Diploma in Public Health (D.P.H.).

OXFORD.—Applications are invited by the Imperial Forestry Institute for a lectureship in tropical forest botany. Candidates must possess a thorough knowledge of tropical systematic and economic botany and ecology with special reference to forest vegetation. The latest date for the receipt of applications, which should be sent to the secretary of the institute, is February 15.

THE University of Manitoba is requiring a lecturer in zoology, to enter upon his duties at the beginning of next year. Applications for the post, together with particulars of candidates' published work, should be received not later than December 6 by the Secretary to the Board of Governors, University of Manitoba, Winnipeg, Canada.

APPLICATIONS are invited by the Denbighshire Education Authority for the principalship of the Acton Hall Technical Institute. Applicants must hold an honours degree in science, and a knowledge of mining is desirable. Applications, ten in number from each candidate, must be received by November 24 at the latest by the Secretary and Director of Education, Education Offices, Ruthin.

AT the annual convocation of the University of Bombay on August 19 the Chancellor, Sir Leslie Wilson, Governor of Bombay, delivered an address on "Democracy," in the course of which, enlarging on the dignity of labour, he observed that there is no reason why a graduate should not drive a plough or a motor-car. India's crying need to-day, he said, is not for Colleges of Arts but for scientific work and vocational training.

AT the time of writing, the following have been elected Parliamentary representatives of the universities of Great Britain and Northern Ireland:—CAMBRIDGE—Mr. J. F. P. Rawlinson (U.), Sir Geoffrey Butler (U.). COMBINED ENGLISH (Birmingham, Bristol, Durham, Leeds, Liverpool, Manchester, and Sheffield)—Sir Martin Conway (U.), Mr. H. A. L. Fisher (L.). LONDON—Dr. E. G. G. Little (Ind.). WALES—Mr. E. Evans (L.). QUEEN'S, BELFAST—Col. T. Sinclair (U.).

WE have mentioned in these columns the guide books and other pamphlets issued this year by the London County Council's Education Committee with the object of popularising the evening classes and other provision for adult education for Londoners. In this connexion it is interesting to note the causes to which the Buffalo Department of Education attributes the popularity of its adult education classes, which were in 1923 attended by one out of every fifteen persons in Buffalo over 16 years of age. These are as follows: Advertisement in newspapers, coloured posters, leaflets taken home by schoolchildren, announcements in motion picture theatres; personal invitations addressed to previous year's students; advisory committees elected by students to keep in constant touch with teachers in regard to subject-matter of courses, units of study and location and hour of classes; and special training for this work of teachers selected on account of their personality and their close acquaintance with the practical side of their subjects.

THE twenty-fifth annual general meeting of the Science Masters' Association is to be held under the presidency of Sir Berkeley Moynihan at the University of Leeds on January 5-7 and will consist largely of lectures and demonstrations by members of the University staff. According to the provisional programme which has been issued, there will be a reception by the Pro- and Vice-Chancellors of the University and Sir Berkeley Moynihan on the evening of January 5, after which the latter will deliver his presidential address. The second day of the meeting will be devoted to lectures and demonstrations, while on the last day there will be a joint discussion with the representatives of the University on the connexion between science teaching in schools and universities, followed by visits to works in the neighbourhood. An exhibition of books and apparatus will be open throughout the meeting. The railway companies are issuing return tickets for the meeting at the rate of a single fare and a third. The honorary secretaries of the Association are Mr. C. E. Sladden, Eton College, and Mr. W. J. Gale, Sloane School, Chelsea.

THE Universities Bureau of the British Empire, which among its many activities has already placed all interested in university education deeply in its debt by the annual production of the Yearbook of the Universities of the Empire, has increased the debt by a pamphlet giving the professional schools and post-graduation courses available in the universities and university colleges of Great Britain and Ireland. The universities are taken in order and under each are given particulars of correlated courses of study such as are generally referred to as "schools" and of specialist studies available at that institution. This is followed by a list of the various "schools"; under each entry is given the centres at which that particular subject can be studied. Finally, there is a list of subjects with the names of centres with which each is particularly associated, so that it is possible from the list to see at a glance where a subject receives special attention. The pamphlet is valuable for reference purposes and should also be extremely useful to colonial and foreign students desirous of pursuing their studies in Great Britain or Ireland. It can be obtained from the Bureau at 50 Russell Square, London, W.C.1.

FROM the Hokkaido Imperial University we have received a pamphlet consisting of replies to a *questionnaire* distributed last year by the League of Nations Committee on Intellectual Co-operation. It covers almost every phase of the university's history, its present condition and plans for the future. The schools of agriculture, forestry, fishery, and civil engineering have since 1918 been frequented increasingly by Chinese students, and some Americans have been attracted by the Fishery School and the entomological collections. In all these schools English has a conspicuous place in the curricula, but all lectures excepting those delivered by foreign teachers of foreign languages (English and German) are now delivered in Japanese. The university farms cover 1500 acres and the university forests more than 300,000. A considerable amount of university extension work is carried on in the form of lectures in scientific subjects for teachers and popular science lectures. The chief publication of the university is the Journal of the College of Agriculture, of which 160 exchange copies are distributed to universities and other institutions in foreign countries, including 65 in the United States, 14 in Great Britain and Ireland, 11 in Germany, and 10 in Australia.

Early Science at the Royal Society.

November 9, 1664. Sir Anthony Morgan promised to draw up a report concerning his majesty's power to give a grant of Chelsea College [Referring thereto, Oldenburg wrote: "Our council is now pressing to have an end of Chelsea College, which we doubt not will prove good; in which case Mr. Howard will be the society's gardiner, without admitting of any competitor, and Dr. Wilkins the weeder"].

1681. The Society was acquainted that Mr. Hodges was in a short time going to the East-Indies to reside at Haukly, upon the river Ganges; and that he was very ready to serve the Society in what he was able in that place.

November 11, 1663. Sir Robert Moray presented from prince Rupert to the Society an instrument of his highness's invention for casting any platform into perspective. It was ordered that the president, Dr. Wilkins [and others] wait upon the prince on the Friday following, and return him the humble thanks of the Society; and to shew him an instrument of Dr. Wren's invention for casting any natural object into perspective. Mr. Hooke suggesting that additions might be made to the invention, so that it might incline and recline, and be fitted to draw likewise solid bodies in perspective, and to describe all kinds of dials, was desired to bring in these additions. In the meantime it was ordered, that the prince's instrument should remain simple, as it was then, without any alteration thereon.—Sir Robert Moray mentioned a new use to be made of thermometers, viz., to know by their help the degrees of heat in a man's body in fevers, etc., by putting it into a man's hand, or mouth, or urine, etc. The physicians present conceived that there would be little certainty in it.

November 12, 1662. Dr. Charlton promised to provide a pike against the meeting for dinner, in order to show every sound tooth moveable.

1668. Mr. Oldenburg read a letter from Monsr. Huygens, in answer to what he had lately written to him by order of the Society, desiring him that if he did not think fit to print what he had discovered on the subject of motion, he would impart to them his theory of it, together with such experiments, as he grounded his theory upon. Monsr. Huygens' answer was, that he was ready to communicate to the society those rules and theorems, which he had found out in all the species of motion.

November 13, 1672. Mr. Locke being called upon for his sulphur-ball, which he promised at the last meeting to produce at this, excused himself, that he had forgot it, promising to bring it at the next.

November 14, 1666. Sir Robert Moray produced a loadstone digged up in England in Devonshire, brought from thence by the sons of Sir William Stroud for the king; which was committed to Mr. Hooke for the repository.

1678. Dr. King upon occasion of discoursing of pearls and bezoar-stones related, that he had often found pearls in the stomach of an oister; and conceived them to be generated as the bezoar-stones in the stomach of a goat.

November 15, 1682. There was a discourse with regard to great age. Mr. Hooke took notice of what Sir Christopher Wren had formerly acquainted the Society, that the people at Hudson's Bay commonly live to 120 or 130 years of age; and till that age are very lusty, and commonly go to hunting, which, when they are no longer able to do, they usually invite all their kindred, and lie down and resign themselves to be strangled by the eldest of those, who survive, and who takes the care of government in his father's stead.

Societies and Academies.

LONDON.

Royal Microscopical Society, October 15.—R. **Clay** and T. H. **Court**: The development of th Hooke microscope. After referring to the descri tion of Hooke's original instrument in his justl famous "Micrographia" (1665) and to the accour given by Sturm in his "Collegium Curiosum (1776) of his experiments with an English Hook microscope which had been lent to him, attentio was directed to the important improvement of th instrument due to Helvelius and described by hi in his "Machina Coelestis" (1673), namely, th screw fine-adjustment. All previous writers ascribe this addition to Marshal, whose celebrated instrumer is first described in Harris' "Lexicon Technicum (1704) (though it had almost certainly been cor structed and used so early as 1693). The failure c earlier writers to mention the important share whic Helvelius had in the development of the microscop is most probably due to the extreme rarity of th "Machina Coelestis."

PARIS.

Academy of Sciences, October 16.—M. Guillaum Bigourdan in the chair.—A. **Lacroix**: Short accoun of the second general meeting of the Internationa Geodesic and Geophysical Union, held at Madrid o October 1-8.—Charles **Rabut**: Scientific rules for th reinforcement of constructions in masonry.—Pau **Montel**: Complex families.—Maurice **Gevrey**: Certai linear integro-differential equations of the secon order.—André **Bloch**: A theorem of M. Borel an a generalisation of the Picard-Landau theory.— E. M. **Antoniadi**: Some changes recently observe on Mars with a telescope of 83 cm. aperture, a Meudon Observatory. These changes are shown o reproductions of eight drawings taken at differen dates.— — **Lyot**: The polarisation of the plane Jupiter.—R. **Dugas**: A system of points of variabl mass.—Louis de **Broglie**: A theorem of M. Bohr.— W. P. **Allis**: The damping of the oscillations of Hertzian resonator. The decrement of the fre oscillations of a resonator is the sum of two terms one of which corresponds to the Joule effect, th other, δ_H, to the radiation. It is shown experi mentally that δ_H is inversely proportional to th square of the wave-length.—C. **Marie** and G. **Lejeune** The influence of colloids on the cathode overvoltag of hydrogen and metals.—René **Audubert**: Photo voltaic phenomena. Details of experiments on th effect of light on the electromotive force of cells th electrodes of which consist of metals carrying a skin of another substance, such as copper oxide, coppe bromide, silver chloride, silver sulphide.—Henr **Lafuma**: The corresponding temperatures of solid bodies. Discussion of a recent communication by M. Brodsky on the same subject.—M. **Bourguel**: A general method for the preparation of true acetylenic hydrocarbons. The acetylene hydrocarbon ($R.C{\equiv}CH$) taken as a starting-point is converted into its sodium derivative (by sodium amide), methylated with methyl sulphate. The resulting hydrocarbon, $R.C{\equiv}C.CH_3$, by heating with sodium amide, is converted into the sodium derivative of the isomer $R.CH_2.C{\equiv}CNa$; this gives readily the hydrocarbon $R.CH_2.C{\equiv}CH$, the next higher homologue of the original $R.C{\equiv}CH$. The yields are high, and details of the application of the method to cyclohexylpropine are given.—E. **Caille** and E. **Viel**: Transformation of the iodostibinates of nitrogenous organic bases into crystallised iodomercurates.—de la

ondamine: The estimation of carbon monoxide in industrial gases. Comparative analyses with ammoniacal cuprous chloride, acid cuprous chloride, and the Damiens cuprous sulphate reagent.—Alfred Schoep: Dumontite, a new radioactive mineral. This new mineral is found as an enclosure in cavities of tobernite from the Belgian Congo. It is a hydrated lead uranyl phosphate.—G. **Rempp** and J. **Lacoste**: New study on the daily variation of the direction of the wind at Strasbourg.—Maurice **Lenoir**: The nucleus of the mother cell of the embryonic sac in *Fritillaria imperialis* observed during its prophasic evolution.—Mme. L. **Randoin** and H. **Simonnet**: The food equilibrium. Maintenance of the pigeon by means of a food regime entirely lacking the water soluble factor.—Charles **Henry**: The radiation of homeotherms and the calculation of nervous sensibilities.—Marcel **Duval**: The amount of sodium chloride in the blood of some marine invertebrates. Contrary to current views, the blood of certain marine invertebrates, particularly crustaceans, contains sodium chloride in slightly lower concentration than the external medium. As the blood and the surrounding sea-water are isotonic, it is probable that the deficiency in the osmotic pressure of the former is made up by the presence of organic substances.—Paul **Fleury**: The laws of action of saccase: influence of the reaction of the medium.—R. **Anthony** and Mlle. F. **Coupin**: A rhinencephalic convolution peculiar to certain carnivora: the *gyrus transversus areæ piriformis*.—E. **Hubault**: The presence of *Liponeura cinerascens* and of *L. brevirostris* in the upper valley of the Meurthe.

WASHINGTON.

National Academy of Sciences (Proc. Vol. 10, No. 8, August).—P. S. **Epstein**: On the simultaneous jumping of two electrons in Bohr's model. A new series in the arc spectrum of calcium ($1p - mp_1$), attributed to the simultaneous jumping of two electrons, has been discovered by H. N. Russell and F. S. Saunders. This condition can be accounted for on the principle of correspondence provided that there is coupling of electrons within the atom.—J. A. **Becker**: The Compton and Duane effects. The two effects may be distinct and their appearance or non-appearance may depend on the intensity of radiation. Using an aluminium crystal as the secondary radiator, the Compton effect (quantum shift) was obtained, and on decreasing the intensity and increasing the time of exposure of the photographic plate, the Duane shift (tertiary radiation) appeared faintly. An additional note states that measurement of the total intensity of scattered radiation in circumstances including both effects has shown that, contrary to expectation, it is proportional to the primary radiation.—E. B. **Wilson**: Coulomb's law and the hydrogen spectrum. Working from the simple equations for force, quantum condition, frequency condition, spectral law and energy, for the electron moving in a circular orbit, it is shown that either Coulomb's law holds, or the law of inverse cubes, involving a quantised force and potential energy, but with no restriction as to the size of the orbit.—Carl **Barus**: Density and diffusion measurement by displacement interferometry in extreme cases. Very high values were obtained for hydrogen; it appears that there is a static error, referred temporarily to the surface tension of the mercury in the gauge.—L. B. **Loeb** and M. F. **Ashley**: Ionic mobilities in gaseous mixtures. The behaviour of ions in gases has been ascribed to two causes: the clustering of neutral molecules about a charged molecule (cluster ion theory); and the attractive forces of a single charged molecule on surrounding neutral molecules (small ion theory). Experiments on carefully prepared ammonia give results which, when related to the concentration of ammonia, are intermediate between what might be expected from the "cluster" and from the "small" ion theories. They are in accord with the hypothesis that mobility varies inversely as the square root of the molecular weight of the gas multiplied by the dielectric constant minus one. This modification of Kaufmann's law can be derived from Sir J. J. Thomson's equations for the mobility of ions.—R. L. **Moore**: Concerning upper semi-continuous collections of continua which do not separate a given continuum.—George E. **Hale**: The spectrohelioscope (see NATURE, Oct. 25, p. 628).—M. T. **Bogert** and J. J. **Ritter**: The constitution of the so-called "Pechmann dyes," and the mechanism of their formation from *beta*-benzoylacrylic acid. These highly coloured dyes, discovered by von Pechmann more than forty years ago, have the same percentage composition as naphthaquinones, but their constitution is different. *Beta*-benzoylacrylic acid seems to be transformed to the enolic form, which then loses water and condenses to a dilactone containing the indigo chromatophore.

Official Publications Received.

Western Australia: Geological Survey. Bulletin No. 89 (revised and amended edition of Bulletin No. 50): The Geology and Mineral Industry of Western Australia. By A. Gibb Maitland and A. Montgomery. Pp. 119. (Perth: Fred. Wm. Simpson.)

U.S. Department of Agriculture: Bureau of Biological Survey. North American Fauna, No. 47: Revision of the American Pikas (Genus Ochotona). By Arthur H. Howell. Pp. iv+57+6 plates. (Washington: Government Printing Office.) 15 cents.

The Rockefeller Foundation. Annual Report, 1923. Pp. xiii+389. (New York: 61 Broadway.)

Sultanic Agricultural Society: Technical Section. Bulletin No. 13: Experiments on the Spacing of Crops. By James Arthur Prescott. Pp. 64. Bulletin No. 14: The Effect of Water on the Cotton Plant; an Account of Experiments conducted at Bahtim on the Irrigation of Cotton. By James Arthur Prescott. Pp. 63. (Cairo.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 491: Theory of Determination of Ultra-Radio Frequencies by Standing Waves on Wires. By August Hund. Pp. 487-540. (Washington: Government Printing Office.) 15 cents.

University of California Publications in American Archæology and Ethnology. Vol. 21, Nos. 1 and 2: The Uhle Collections from Chincha, by A. L. Kroeber and William Duncan Strong; Explorations at Chincha, by Max Uhle. Pp. 94+24 plates. (Berkeley, Cal.: University of California Press.) 1.60 dollars.

Bulletin of the National Research Council. Vol. 9, Part 1, No. 48: Critical Potentials. By K. T. Compton and F. L. Mohler. Pp. 125. (Washington, D.C.: National Academy of Sciences.) 1.60 dollars.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 30 (Botanical Section): A Banana Disease caused by a Species of Heterodera. By Tewfik Fahmy. Pp. ii+11+9 plates. 5 P.T. Bulletin No. 38: A Multiple Temperature Incubator. By C. B. Williams and T. W. Kirkpatrick. Pp. iv+9. 3 P.T. (Cairo: Government Publications Office.)

Ceylon Journal of Science. Section B: Zoology and Geology. Spolia Zeylanica. Vol. 13, Part 1, September 16th. Pp. 141. (Colombo: Colombo Museum; London: Dulau and Co., Ltd.) 3 rupees.

University of California Publications in American Archæology and Ethnology. Vol. 17, No. 5: Nabaloi Tales. By C. R. Moss. Pp. 227-353. 1.75 dollars. Vol. 17, No. 6: The Stege Mounds at Richmond, California. By Llewellyn L. Loud. Pp. 355-372+2 plates. 35 cents. (Berkeley, Cal.: University of California Press.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. Vol. 1, No. 8: Kinematographic Study on Aeronautics. By Kwan-ichi Terazawa, Kichisuke Yamazaki, and Yûzô Akishino. Pp. 213-224+plates 16-18. (Tôkyô: Maruzen Kabushiki-Kaisha). 1 Yen.

Auxiliary Tables of the Survey of India. Fifth edition. Revised and extended by Dr. J. de Graaff Hunter. Part 1: Graticules of Maps. Pp. 25. 1 rupee; 2s. Part 2: Mathematical Tables. Pp. xiii+89. 2 rupees; 4s. Part 3: Topographical Survey Tables. Pp. xxi+52. 1.8 rupees; 3s. (Dehra Dun: Trigonometrical Survey.)

Bernice P. Bishop Museum. Bulletin 10: Report of the Director for 1923. By Herbert E. Gregory. Pp. 38. Bulletin 11: Vocabulary of the Mangaian Language. By F. W. Christian. Pp. 31. Bulletin 12: The Island of Lanai; a Survey of Native Culture. By Kenneth P. Emory. Pp. 129+11 plates. Bulletin 13: Bibliography of Polynesian Botany. By E. D. Merrill. Pp. 68. Bulletin 14: The Characters and Probable History of the Hawaiian Rat, by Gerrit S. Millar, Jr.; Ectoparasites of some Polynesian and Malaysian Rats of the Genus Rattus, by H. E. Ewing. Pp. 11. (Honolulu, Hawaii.)

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1923-24. Vol. 68. Pp. 148+xxxvi+vii. (Manchester: 36 George Street.) 12s.

Diary of Societies.

SATURDAY, NOVEMBER 8.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10 A.M.—Dr. J. Kerr Love: Some Neglected Corners of the Otological Field (Presidential Address).

MONDAY, NOVEMBER 10.

ROYAL IRISH ACADEMY (Dublin), at 4.15.

BIOCHEMICAL SOCIETY (in Physiological Department, St. Bartholomew's Hospital), at 5.—G. Thomas: Micro-estimation of Urea in 0·2 c.cm. of Blood.—E. Holmes: Excretion of Salicyluric Acid after Ingestion of Sodium Salicylate by the Human Subject.—R. E. Chapman: Carbohydrate Enzymes of Starch-free Monocotyledons.—E. M. Hume and H. Henderson Smith: Effect of Ultra-violet Irradiation of Environment on Growth and Calcification of Rats fed on Vitamin A-deficient Diet.—G. A. Harrison: Effect of Insulin on Cholesterolæmia.—R. L. Mackenzie Wallis: Observations on Glucose and Lævulose Tolerance Tests.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Major R. W. G. Hingston: Physiological Difficulties in the Ascent of Mount Everest.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—P. Dunsheath and others: Discussion on Research in the Cable Industry.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.—S. C. Bartholomew: Power Circuit Interference with Telegraphs and Telephones.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—C. E. Henshaw: An Outline of the Process of Casting in Bronze by the "Cire Perdue" Method.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.), at 8.—Judge Dowdall: What is a Society?

SURVEYORS' INSTITUTION, at 8.

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. E. F. Buzzard and others: Discussion on Encephalitis Lethargica.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Anatomy School, Cambridge), at 8.45.—Sir Ernest Rutherford: The Natural and Artificial Disintegration of Elements.

TUESDAY, NOVEMBER 11.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. Singer: The History of Anatomy (Fitzpatrick Lectures) (1).

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.—D. E. Batty: The Electric Road Vehicle—its Characteristics and its Economic Field of Usefulness.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—T. B. Johnson: Chairman's Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at 207 Bath Street, Glasgow), at 7.30.—A. Lindsay: Chairman's Address.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—G. C. Robson: Brackish Water Fauna.

INSTITUTE OF CHEMISTRY (Students' Association, London), at 8.—Debate.

WEDNESDAY, NOVEMBER 12.

PREHISTORIC SOCIETY OF EAST ANGLIA (at Geological Society), at 2.15.—Dr. C. Fox: A Settlement of the Early Iron Age at Abington Pigotts, Cambs.—H. Dewey and J. P. T. Burchell: The Gravels at Reculver, Kent.—R. A. Smith and W. H. Cook: Report on the Discovery of a St. Acheul-Moustier Floor near Rochester, Kent.—A. L. Armstrong: Recent Excavations at Grimes' Graves.—J. Witham: An Account of Researches and Discoveries in the Burnley District of S.E. Lancashire.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Sir Richard Owen as Conservator (Thomas Vicary Lecture).

NEWCOMEN SOCIETY (Annual General Meeting) (at Caxton Hall, Westminster), at 5.30.—T. Rowatt: Some Original Models of Smeaton's Eddystone Lighthouse.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Discussion on the New I.E.E. Wiring Regulations (Buildings).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduates Section) (at Bolbec Hall, Newcastle-on-Tyne), at 7.—G. L. Hutchinson: The Corrugated Ship.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Graduates Section) (at Chamber of Commerce, Birmingham).

THURSDAY, NOVEMBER 13.

ROYAL SOCIETY, at 4.30.—N. K. Adam and J. W. W. Dyer: The Molecular Structure of Thin Films. Part VI.—T. Alty: The Cataphoresis of Gas Bubbles in Water.—*To be read in title only*:—D. R. Hartree: Some Relations between the Optical Spectra of Different Atoms of the same Electron Structure. I. Lithium-like and Sodium-like Atoms.—P. A. M. Dirac: The Conditions for Statistical Equilibrium between Atoms, Electrons, and Radiation.—Ida Doubleday: Boundary Lubrication. Further Consideration of the Influence of the Composition of the Solid Face.—Christina C. Miller: The Stokes-Einstein Law for Diffusion in Solution.—Helen S. French and Prof. T. M. Lowry: Studies of Co-ordination. Part I. Absorption Spectra and Co-ordination of some Cupric Compounds.—L. F. Bates: The Range of α-Particles in Rare Gases.—D. H. Black: The β-Ray Spectrum of Mesothorium 2.—J. Keith Roberts: The Thermal Expansion of Crystals of Metallic Bismuth.—R. Stoneley: Elastic Waves at the Surface of Separation of Two Solids.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Engineers' Club, 39 Coventry Street, W.), at 5.—F. M. Potter, H. C. Marris, and others: Discussion on Chemical Works Costs.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. Singer: The History of Anatomy (Fitzpatrick Lectures) (2).

LONDON MATHEMATICAL SOCIETY (Annual General Meeting) (at Royal Astronomical Society), at 5.—Prof. W. H. Young: The Progress of Mathematical Analysis in the Twentieth Century (Presid Address).—H. Causdale: General Equation of the n-th Degree.—Chaundy: Poncelet's Poristic Polygons (Second Paper).—Pr Hilton: Successive Evolutes of a Plane Curve.—E. L. Ince: Th Zeros of Solutions of a Linear Differential Equation with Period efficients.—A. E. Ingham: Some Tauberian Theorems of Hard Littlewood.—J. E. Littlewood: The Riemann Zeta Function.—Milne: Contravariant Envelopes of the Plane Quartic Curve.—Titchmarsh: (1) The Convergence of Certain Integrals; (2) An Inv Formula involving Bessel Functions.—Dr. D. M. Wrinch: A Cl Problems in Electrostatics and Hydrodynamics.

ROYAL AERONAUTICAL SOCIETY (at 7 Abermarle Street, W.), at 5 Prof. L. Bairstow: Skin Friction.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Comma Mary Allen: Women Police Work among Children.

OPTICAL SOCIETY (at Imperial College of Science and Technolog 7.30.—T. Smith: (*a*) The Back Vertex Power of a Combinati Lenses; (*b*) The Theory of Neutralisation.—R. Kingslake: A Type of Nephelometer.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Section) (at U sity College, Dundee), at 7.30.—G. Rogers: Automatic and Automatic Mercury-Vapour Rectifier Substations.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre) (at Trinity Co Dublin), at 7.45.—Discussion on the New I.E.E. Wiring Regula (Buildings).

INSTITUTE OF METALS (London Local Section) (at Royal School of M at 8.—Prof. T. Turner: Oxidation, with special reference to Films.

INSTITUTION OF MECHANICAL ENGINEERS (Cardiff Section).

SOCIETY OF DYERS AND COLOURISTS (Bradford Junior Branch Bradford).—L. S. Priestley: The Conditioning of Cotton and Art Silk.

FRIDAY, NOVEMBER 14.

DIESEL ENGINE USERS' ASSOCIATION (at Engineers' Club, Coventry St W.), at 3.30.—Further Report of Committee on Heavy Oil E Working Costs.

ROYAL ASTRONOMICAL SOCIETY, at 5.—T. C. Hudson: Perturbati Directivity.—Prof. I. Yamamoto: Some Relations between the Constant and Solar Activity.—Prof. W. G. Duffield: The Proble Measuring Gravity at Sea.—M. C. Johnson: Scattering and Absor in the Atmospheres of Emission Line Stars.—A. Buxton: Not Expressions for the Measurement of the Effect of Diffraction and Presence of Optical Aberrations in the Images of Point, Line, and P Luminous Sources.—N. Goryatchew: Occultations of Stars by the M observed at the University Observatory, Tomsk, Siberia, 1923, 19 Dr. J. Lunt: The Spectrum of Germanium.—S. D. Tscherny: Occ tion of Venus by the Moon, 1924, Sept. 24, observed at the Astronon Observatory, Kiew.—W. S. Franks: Observed Colours of 205 Red S —N. Liapin: The Transit of Mercury across the Sun's Disc, 1924, M as observed at the University Observatory, Simferopol, Crimea.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at D. W. Dye and L. Hartshorn: The Dielectric Properties of Mic Dr. L. Simons: The X-ray Emission of Electrons from Metal Fi with Special Reference to the Region of the Absorption Lim Dr. W. H. Eccles: Demonstration of an Electrical Method of thesising Vowel Sounds.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at Ardrossan), at J. G. Roberts: Chemical Pottery.

JUNIOR INSTITUTION OF ENGINEERS (Annual General Meeting), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—G. Aven Round about Swanage (Lantern Lecture).

INSTITUTE OF METALS (Swansea Local Section) (at University Coll Swansea), at 7.15.—Dr. W. Rosenhain: The Inner Structure of Allo

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS Newcastle-upon-Tyne), at 7.30.—J. F. King: Girders in Ships.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Section).—Vice-Adm Sir George G. Goodwin: The Trend of Development of Marine Propel Machinery (Thomas Hawksley Lecture).

SOCIETY OF DYERS AND COLOURISTS (Manchester Junior Branch) Manchester).—Dr. R. S. Willows: Studies in Liquid Films.

SATURDAY, NOVEMBER 15.

PHYSIOLOGICAL SOCIETY (at London Hospital).

PUBLIC LECTURES.

SATURDAY, NOVEMBER 8.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: The Amulets Ancient Egypt and Modern London.

WEDNESDAY, NOVEMBER 12.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Sir Leonard Rogers: Lepr as an Imperial Problem.

UNIVERSITY COLLEGE, at 5.30.—J. C. Gröndahl: Nature Feeling Norwegian Literature. (Succeeding Lectures on November 19, 26. G. F. Barwick: The British Museum Library—I. The Reading Roon

THURSDAY, NOVEMBER 13.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Prof. W. Wilson: Atoi Structure and Quanta.

UNIVERSITY COLLEGE, at 5.30.—Dr. C. Pellizzi: La dottrina sociali storica di G. B. Vico (in Italian).

FRIDAY, NOVEMBER 14.

KING'S COLLEGE, at 5.30.—Prof. L. T. Hobhouse: Scientific Method.

SATURDAY, NOVEMBER 15.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. H. S. Harrison: Evolut and Darwinism.

NATURE

SATURDAY, NOVEMBER 15, 1924.

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON

The State and Productive Research.[1]

BY Order in Council of July 28, 1915, the Committee of the Privy Council for Scientific and Industrial Research was established "to direct, subject to such conditions as the Treasury may from time to time prescribe, the application of any sums of money provided by Parliament for the organisation and development of scientific and industrial research." The Order in Council further provided that there should be an Advisory Council to which should stand referred, for its report and recommendation, proposals—(1) for instituting specific researches; (2) for establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades; and (3) for the establishment and award of research studentships and fellowships.

On December 1, 1916, the work of the Committee of Council for Scientific and Industrial Research with that of its Advisory Council, hitherto under the ægis of the Board of Education, was assigned to a separate department—the Department of Scientific and Industrial Research—having its own estimates in charge of a minister responsible to Parliament. This was followed by the creation, under His Majesty's Sign Manual, of the Imperial Trust for the Encouragement of Scientific and Industrial Research, to hold funds, to enter into contracts and agreements, and to do other things in furtherance of the objects of the Committee of Council for Scientific and Industrial Research.

Parliament having voted the sum of one million sterling for the purposes of the Department, the fund was deposited with the Imperial Trust to be expended in accordance with the directions of the Committee of Council. On the recommendation of the Advisory Council, the Committee of Council decided that the money should be spent in the form of grants in aid of research in any industry undertaken by firms which might combine to conduct it on a co-operative basis. The means devised to this end was the establishment under the Companies Acts of Associations for Research limited by guarantee and trading without profit. The number of these industrial research associations in actual operation to-day is twenty-three, and there is one which has not yet commenced full operations.

The position of the Research Associations and their future in the industrial system of Great Britain are well worth separate consideration, but as the policy of establishing them at all has been challenged, even in quarters unquestionably anxious to promote the fullest use of scientific knowledge, it may be well to say a

[1] Report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1923–24. (Cmd. 2223.) Pp. iv+139. (London: H.M. Stationery Office, 1924.) 3s. net.

word on the general question. That question is, granted that a million fund is for disposal to bring the results of scientific research to the continuous aid of industry, is the method of establishing research associations the best method, or at least as effective as any other method, of doing so? The Advisory Council, in its annual report for 1919–20, says:

"It may be said that a million spent upon research work done at the National Physical Laboratory and other research laboratories up and down the country would produce much greater scientific results of value to industry than the same sum spent in subventions to associations that have to buy their experience as well as their staff and equipment at a time when the country is short of both. It may be so. But it is only after the industries have done research for themselves that they can appreciate either its difficulty or its worth. They are trained to suspect that what can be got for nothing may have a corresponding value. Had the million been spent on research directed by the Government itself, its effect upon manufacturers would at the best have been destructive of their self-reliance and at the worst a free gift to their competitors in other lands."

To the writer these considerations seem sound and over-riding. The essential problem would not be solved by the mere increase, in quantity and quality, of the results of scientific research of value, direct and indirect, to industry. It was a part, and not the least part, of the problem to get science domiciled in the industries themselves; to bring about an interfusion, not only of the theoretical knowledge of the man of science and the practical knowledge of the manufacturer, but also of the corresponding personalities; and to make the manufacturers themselves (in greater or less degree, according to the character of the industry) working, and not sleeping, partners in scientific research. It is difficult to see what better means to these ends could have been adopted than the method of industrial research associations.

On one major point, however, there may well be doubt and criticism. The scheme was based on the expectation that at the end of the first five years the industries concerned would find themselves both willing and able to continue the work of their respective research associations without direct assistance from the State. On this, two things may be said. In the first place, five years is too short a period in which to bring practical conviction of the benefits and necessity of co-operative research to industries, presumably, needing to be convinced, and the course of economic events since the War, including the long period of industrial depression, has enhanced this difficulty. In the second place, the State may well lose more of real wealth by cutting the research associations adrift than it can gain in money saved by the withdrawal of grants in aid. It is to be hoped that the Committee of Council will give further careful consideration to this aspect of the question and will not regard as an axiomatic principle the proposition that research associations must, after a limited period, "look solely to the industries they represent for their maintenance."

To obtain a just idea of the work of the Department of Scientific and Industrial Research, we have to consider, however, much more than the work of the Research Associations. In carrying out its duties, the Advisory Council gradually evolved a definite programme under four main heads: (1) the encouragement of the individual research worker, particularly in pure science; (2) the organisation of national industries into co-operative research associations; (3) the direction and co-ordination of research for national purposes; and (4) the aiding of suitable researches undertaken by scientific and professional societies and organisations. It would be impossible in a single article to give even the barest summary of the work done under these heads, and the reader who is interested may be referred to the annual reports of the Department. There, for example, he will learn what has been done and attempted "in the direction and co-ordination of research for national purposes" in the records of the Fuel Research Board, the Food Investigation Board, Forest Products Research Board, Building Research Board, and so on.

The Department has also done much to co-ordinate the various scientific activities of government. In 1918 the property of the National Physical Laboratory, together with the responsibility for its maintenance and development, was transferred to the Department, and in 1919 the administration of the Geological Survey and Museum was similarly transferred. In 1919–20 on the decision of the Cabinet, Co-ordinating Boards were established, with the object of so organising all the scientific work which is of common interest to the Fighting Services of the Crown as to ensure the utmost economy of expense and personnel, and the due co-ordination of the technical work of the various naval, military, and aeronautical establishments so as to avoid overlapping, either with each other or with the research organisations of the Civil Departments of State. At present there are four such Co-ordinating Boards, for chemistry, engineering, physics, and radio research. They include technical representatives of the Fighting Services and Civil Departments.

Reviewing the work and development of the Department of Scientific and Industrial Research since its foundation, the question arises, has the experiment of governmental participation in the organisation of scientific research, especially in its relation to industry, so far as it has gone, been justified? To that question,

ere can be little doubt that the answer is in the irmative. If there have been mistakes in detail, realised expectation here and, apparently, wasted ort there, the instances have been at least as few as, d perhaps fewer than, could reasonably be counted , for a like period, in the early stages of development any new government department. As to the value the work itself, it is sufficient to quote the words of e Advisory Council: "Scientific research is, in our dgment, the main, if not the only source of fresh oductivity in industry, and it is only by increased oductivity that the world will find a way out of its esent economic difficulties."

What, taking a broad view, has been done towards is end by the establishment and work of the Depart-ent of Scientific and Industrial Research?

We have now a Government Department as fiduciary r science, charged with the duty and responsibility ensuring, in so far as Government can ensure, that ientific knowledge and methods play their full part the Government services and in the trade and dustry of Great Britain.

We have Research Associations in twenty-three or wenty-four diverse industries, not only engaged directly scientific research, but also acting as scientific centres here all scientific questions affecting their respective dustries can be brought to a focus, and in the solution f which the scientific worker, the manufacturer, and he user can each play his appropriate and co-ordinated art.

The scientific worker and the manufacturer have been brought into closer co-operation, the gulf between heory and practice has been narrowed, and, in greater r less degree, the manufacturers themselves have become productive partners in research.

The spirit of co-operation between individual firms n an industry and between industries generally and the Government services has been quickened and enlarged.

Researches have been initiated and prosecuted, already with appreciable success, into fundamental problems of national importance (for example, fuel, food, and building materials), which no one firm and no one industry could be expected to undertake on an adequate scale.

The man of science has been helped to come into his own, and a powerful reinforcement has been brought to the aid of those who have long sought to bring vividly to the minds of all classes a realisation of the degree and extent to which our modern industrial civilisation is based upon, and must be shaped by, the progress of scientific discovery.

Not least, a good beginning has been made in the evolution of a national scientific policy. Continuity in foreign policy has been the aim of successive governments since the days of Lord Salisbury. By wise and prudent direction, by advancing, to use a phrase of Lord Morley, "with daring caution," the Department of Scientific and Industrial Research may give us an accepted national scientific policy, definite, continuous, and consistent.

J. W. WILLIAMSON.

History of Mathematics.

History of Mathematics. By David Eugene Smith. Vol. 1: General Survey of the History of Elementary Mathematics. Pp. xxii + 596. (Boston and London: Ginn and Co., 1923.) 21*s.* net.

IT is only during the last fifty or sixty years that the history of mathematics has been systematically studied. In that time, however, the field has been gradually covered by an increasing number of students, and their output has become so extensive that it was no work of supererogation when Prof. Gino Loria thought it necessary to publish a guide to the literature of the subject, old and new, "Guida allo studio della storia delle matematiche" (Hoepli, 1916). There are indeed already in existence general histories of mathematics of all sorts and sizes, designed to meet the requirements of almost all varieties of readers. The great work of Moritz Cantor ("Vorlesungen über Geschichte der Mathematik"), which may be regarded as the inspirer of most of them, appeared in the years from 1880 to 1908 and consists of four volumes, with an aggregate of some 3800 large pages. Yet it contains no unnecessary details—in many places in the earlier volumes the reverse is the case—and it does not carry the story beyond 1799: this is a sufficient indication of the extent of the material.

Cantor's history has not been translated into English, partly, we may suppose, because it would be a formidable undertaking, but also, no doubt, because the book is, so far as the early volumes are concerned, already out-of-date, the later editions having failed to take sufficient account of the results of recent researches and of the many corrections and well-founded criticisms of details in the first edition. Among the shorter histories covering approximately the same ground may be mentioned the "Geschichte der Mathematik" designed for the "Sammlung Schubert," in two volumes, the first (1908) by Siegmund Günther (pp. 427), and the second in two parts (1911 and 1921) by Heinrich Wieleitner (pp. 251 and 220), a competent work of convenient size. Much smaller still was the "Geschichte der Mathematik" in the "Sammlung Göschen," by A. Sturm, which essayed to tell the story in 155 small pages; this has now been re-edited in two parts (1922–1923) by Wieleitner (pp. 136 and 154), and contains the very utmost that could be compressed into the small space, so much so that it can scarcely be read continuously for any length of time without inducing a headache.

The histories in French, apart from the pioneer work of Montucla (first edition 1758, second edition, completed by Lalande, 1799–1802), are of no great account. One is by M. Marie in twelve slender volumes ("Histoire

des sciences mathématiques et physiques," 1883–1888); the volumes relating to antiquity are, however, untrustworthy. Another by F. Hoefer (1874) has passed through several editions, but is now out-of-date. A third, by J. Boyer (1900), is a mere sketch in 260 pages, but it has some interesting portraits. In English we have the work by W. W. Rouse Ball with the modest title "A Short Account of the History of Mathematics" (first edition 1888), an attractive book the success of which is proved by the number of editions that have been called for; there is also the slighter "History of Elementary Mathematics" by Florian Cajori (New York: The Macmillan Company, 1897).

Cantor was able to complete the first three volumes of his "Vorlesungen" himself, covering the period down to 1758; but for the fourth volume dealing with the period from 1759 to 1799, he was constrained to enlist the co-operation of other specialists, each of whom took one department or section; thus S. Günther wrote upon the works bearing on the history of mathematics which belong to the period in question, F. Cajori on arithmetic, the theory of equations and the theory of numbers, E. Netto on combinatorial analysis, probability, series and the imaginary, V. Bobynin on elementary geometry, A. von Braunmühl on trigonometry, polygonometry and tables; and so on. This devolution of the work meant a change of arrangement; whereas the earlier volumes all followed chronological order, the fourth volume abandoned this plan in favour of an arrangement by subjects. This becomes a necessity if the development of the several branches of mathematics is to be systematically set forth and properly understood. The chronological method with a proper admixture of biography and anecdote is no doubt more suitable for the ordinary cultivated reader with just a sufficient mathematical equipment to enable him to understand what he is reading; the other arrangement, according to subjects, better serves the purpose of the expert mathematician, amateur or professional.

This was seen by J. Tropfke, who in the years 1901 to 1903 brought out the two volumes of his "Geschichte der Mathematik in systematischer Darstellung" (1922 saw the commencement of publication of a second edition). This excellent work is divided into fourteen sections dealing with separate subjects, namely, arithmetical calculation, algebra, plane geometry, logarithms, plane trigonometry, sphaeric and spherical trigonometry, series, interest-calculations, combinatory analysis and probability, continued fractions, solid geometry, analytical geometry, conics, maxima and minima. Thus, whereas the earlier histories adopted, after Cantor, a chronological arrangement, Tropfke's amounted rather to a series of historical monographs on the origins and development of the main subjects included in a regular programme of mathematical instruction.

Dr. Smith, in the two volumes into which his work is divided, aims at fulfilling a double purpose. The first volume, now before us, is designed to afford a survey of the growth of mathematics by chronological periods, and to give a general historical presentation "for the purpose" (in his own words) "of relating the development of mathematics to the development of the race, of revealing the science as a great stream rather than a static mass, and of emphasizing the human element." "But this" (he continues) "ought to lead to a topical presentation by which the student may understand something of the life history of the special subject which he may be studying, whether it be the elementary theory of numbers, the methods of calculation, the solution of equations, the functions of trigonometry, the common symbolism in use, the various types of elementary geometry, the early steps in the calculus, or one of the various other important topics of elementary mathematics." This latter presentation of the subject is reserved for the forthcoming second volume. We may say therefore, roughly, that our author seeks to combine the aims of writers like Rouse Ball on one hand and of Tropfke on the other, the first volume of his work corresponding to Rouse Ball's "Short Account" and the second to Tropfke's history.

We can only wish Dr. Smith success in his undertaking. There is certainly room for a volume in English on Tropfke's plan, while the first volume is in many ways attractive. It is true that, in comparison with Ball's "Short Account," the first volume has a certain disadvantage in that, when the author would naturally give us some piece of actual mathematical work, he has (in order to avoid repetition) to break off and refer us, for details, to the forthcoming volume. While, therefore, he is able, like Ball, to give details of the lives of mathematicians and stories about them which contribute to make the volume eminently readable, some portions of certain chapters tend to become little more than lists of names of writers with a statement of the subjects on which they wrote or in which they were interested. Dr. Smith is, however, fully aware of this disadvantage. On the other hand, there are special features which add to the usefulness and attractiveness of the volume. One is the remarkably full references in the notes to the literature and bibliography of the subject, for which students who desire to pursue it further cannot fail to be grateful. Another is the large number of portraits of mathematicians (on which Dr. Smith is a recognised authority), and of facsimiles of pages from manuscripts and rare and famous printed books, as well as of extracts from letters

memoranda in the handwriting of the most famous mathematicians. The facsimiles, unfortunately, have often to be on a reduced scale, but this is rendered inevitable by the size of the page.

In a work containing so much detail it is, of course, impossible to avoid occasional slips. To take only the section dealing with Greek mathematics:—We are puzzled by the statement on p. 73 that "for the doctrines of Pythagoras we are indebted chiefly to Eudoxus of Cnidus (*c.* 370 B.C.), whose works, though lost, are known to us through extracts preserved by later writers"; is the reference, perhaps, intended to be to Eudemus of Rhodes? On p. 86 we are told, as regards Theaetetus, that "there are references in the writings of the ancient historians to show that he discovered a considerable part of elementary geometry and wrote upon loci." We know of no authority for the statement that Theaetetus wrote on loci; is it possibly due to an inadvertent mis-reading of the dictum in Proclus's "Summary" [that "*Hermotimus of Colophon* carried further the investigations already opened up by Eudoxus and Theaetetus, discovered many propositions of the Elements and compiled some portion of the theory of loci"? The statements, on p. 59, that the Egyptians knew the fact relating to the square on the hypotenuse of a right-angled triangle long before Pythagoras, and on p. 72, that we have the best evidence for this, need modification since the publication of the new edition of the Rhind Mathematical Papyrus by Prof. Eric Peet; for we are assured by Prof. Peet that he has been able to find no foundation whatever for the idea that the Egyptians knew the fact in question, and that nothing in Egyptian mathematics suggests that the Egyptians were acquainted even with special cases of the Pythagorean theorem. T. L. H.

Tissue Growth.

Growth. By G. R. de Beer. Pp. viii + 120 + 8 plates. (London: E. Arnold and Co., 1924.) 7*s.* 6*d.* net.

THE experimental study of tissue growth is a comparatively recent branch of biological research, and as yet but a small part of this vast field has been explored. Much important work, often of tantalising suggestiveness, has already been carried out, however, and various hypotheses have been put forward to explain the forces which initiate, sustain, perpetuate and control the growth of cells. At the present time the problem of growth is being approached from many widely diverse points of view. The embryologist, the physiologist, the geneticist, the biochemist are all engaged upon its solution, and it is therefore a matter of some difficulty for the layman, or indeed for the specialised research worker, to obtain a comprehensive view of the more significant facts which recent investigation has brought to light. Mr. G. R. de Beer, in his book "Growth," has successfully summarised and discussed in popular language some of the results achieved in relation to this subject in various branches of science during recent years.

The author opens his introductory chapter with a statement of the object of his book, "to show what growth is, what it does, and how it does it"—perhaps a somewhat ambitious aim in the present state of our knowledge. If he could satisfactorily explain the third division of his text, "how it does it," he would have solved one of the most perplexing problems in Nature. He has, however, brought together a number of interesting experiments and observations relative to growth in the plant and animal kingdoms in a clear, concise, and interesting manner. It is pointed out that growth alone is not responsible for the formation of an intricate adult organism out of a simple spherical ovum, but that the many complex processes involved in embryonic development fall into two headings: increase in size and increase in complexity of structure and shape, or, in other words, growth and differentiation. A short account of the growth of animals, the development of the frog being selected as the example, is followed by a brief description of growth in plants and a short chapter containing a few special examples of growth and differentiation in animals.

Growth, it is pointed out, is not confined to embryonic life; the processes of adult existence—metabolism and expenditure of energy—entail a continual breaking down of the tissues which must be replaced if the organism is to persist. This physiological regeneration goes on throughout life and is effected by cell division, but does not necessarily cause any increase in size. A very striking example of normal regeneration is quoted, which occurs regularly among the Polyzoa. In these animals the nervous and alimentary system degenerates into a mass of decomposing matter, and at the same time a new alimentary canal and nervous system are produced by growth. As Mr. de Beer remarks, this form of regeneration "is a very convenient method of 'doing up' the organism." A short chapter is devoted to the question of asexual reproduction, illustrated by various examples from the animal and vegetable kingdom. The author then passes to the subject of abnormal growth, which he defines as growth which plays no part in the normal life cycle of the organism, but rather the reverse, and mentions various examples of galls in plants and tumours in animals. A most remarkable case of abnormal growth here described is that of a fungus *Rozites gongylophora*, "which is carefully cultivated on specially produced manure beds by the leaf-cutting ant

(Atta) in Brazil. Ordinarily this fungus produces spores, but under the treatment to which it is subjected by the ants it grows into white swellings which are used by the ant as food."

Having made a general survey of the various forms of tissue growth, the author proceeds to discuss its causes and nature. He likens protoplasm with its ceaseless metabolism to "a whirlpool which involves now one particle of water, now another"; at no time can it be said that it consists essentially of any particular portion of matter, for the essence of the whirlpool is the "whirl." The genetical aspect of growth is briefly considered along Mendelian lines. The nature of fertilisation is also touched upon, and a short account is given of the more obvious chemical processes which accompany the conversion of non-living food-material into living protoplasm.

Vitamins and hormones, "substances which speed up growth," are accorded a short chapter, which is followed by an interesting account of the effect of external factors upon growth and the relationship of certain physical conditions to the limitation of size in various organisms.

The rate of growth and the control of growth by differentiation and age are discussed, and a chapter on growing smaller or "degrowth" follows. A few pages are devoted to inorganic analogies, growth being compared with crystal formation and other physical and chemical processes. The author wisely concludes, however, that "inorganic analogies, while very instructive and illustrative of certain events in the reactions of living matter, are as yet unable to throw much light on growth itself."

In his final chapter, Mr. de Beer reviews the problem of growth in its more general aspect, and remarks that "there is no need to invoke mystical forces to explain results which in the present state of knowledge are not understood. The processes of growth most certainly have their causes, but these causes are not likely to be understood until the chemical and physical properties of living matter have been thoroughly explored."

It is always a matter for regret that science should guard her treasures from the general public by a bristling array of formidable technicalities, and Mr. de Beer is therefore to be congratulated on reducing our knowledge of one of the most important, and at the same time one of the most difficult subjects in biology, to a form in which it can be appreciated by the man in the street. The results of much important research must of necessity be omitted from a work of this scope, but the material on the whole is well selected, and the volume will be a welcome addition to the shelves of biological students and also, it is to be hoped, to members of the general public.

T. S. P. S.

Physics for All.

(1) *Our Physical World: a Source Book of Physical Nature Study.* By Elliot Rowland Downing. With a Chapter on Radio Communication, by Fred G. Anibal. (University of Chicago Nature-Study Series.) Pp. xviii + 367. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press, 1924.) 2.50 dollars.

(2) *Matter and Change: an Introduction to Physical and Chemical Science.* By William Cecil Dampier Whetham. Pp. vii + 280 + 3 plates. (Cambridge: At the University Press, 1924.) 7*s.* 6*d.* net.

IT is generally admitted at the present time that science in some shape or form should be part of the general education of every boy. Whatever his main interests are to be, whether he is to be a serious student of other branches of learning, or a man of affairs, it is almost unthinkable that he should leave school without some instruction in the aims and methods of science. In particular, in these times when strange stories of fabulous inventions seem to have replaced the giant gooseberry and the sea-serpent in the columns of the ephemeral press, some knowledge of the principles of physics seems a desirable part of the education of all good citizens; though physics presents, perhaps, his greatest problem to the teacher of "science for all." There is no time, in the few hours which are all that science can claim in a curriculum of general education, for the tedious process by which the "specialist" prepares the foundations for his higher studies in science; nor does it seem desirable that time and energy should be spent on laying elaborate foundations upon which nothing is to be erected subsequently. The selection of material, from so vast a storehouse, the nature of its presentment, the degree of rigour to be aimed at, are engaging the deepest attention of many of our most enthusiastic and capable teachers. It is not surprising that books on the subject multiply rapidly. Two are before us as we write. They reflect, in their extremest form, the divergences which exist as to what is possible and desirable in the way of the teaching of physics as part of a general education.

"Our Physical World," by Prof. Downing, is dated from the School of Education of the University of Chicago, and may be taken to represent the point of view of the practical educational expert, with a vivid—possibly painful—apprehension of the difficulties of his craft, and a realisation of the limitations of the human material with which he has to deal. The schoolboy's attention is to be won, and his interest stimulated, by the proof that science has something to say about subjects which really matter—kites and tin whistles, tops and toy aeroplanes, bows and arrows, and motor cars. The scientific pill must be carefully sugared, and

the exigencies of confectionery leave little space for the operative principles which it is the purpose of the writing to convey, that is one of those unfortunate facts which the teacher must face and accept.

In "Matter and Change," on the other hand, Mr. Whetham has obviously found his subject of such enthralling interest that he has not conjectured the possibility that any reader should find it less so, or should need any inducement beyond the subject itself to pursue his studies with diligence and enthusiasm. Save for the delightful clarity of style, which is a distinguishing feature of all Mr. Whetham's writings, and for the humanising touches provided by illuminating biographies, one line long, which help us to realise that even scientific investigators are men, there is no concession to human weakness or boyish indolence. Probably the true method lies somewhere between these extremes.

(1) Prof. Downing's book, though very readable and well illustrated, does not strike us as one of the best of its kind. Although nominally a "source book" for teachers of the subject, the author frequently appears to be addressing the pupils themselves. We hope, at least, that there are no science teachers in the United States who require the caution that "The North Pole is not a real pole sticking up out of the earth." Nor does it seem that the younger pupils, for whom some of the very elementary portions of the book are clearly intended, could glean much of value from the account of the electron theory of matter, or from the excellent chapter on radio communication. There is a similar want of sureness of purpose in the choice of material. Instructions for making a bird kite are followed by an excellent historical account of the progress and development of aviation, and a description of a toy windmill is followed by an impassioned appeal against allowing the valuable water-power of the States to fall into private hands. A chapter on the electrical theory of matter, including with a two-page synopsis of chemical theory, is succeeded by an historical account (again very well done) of the development of the steam-engine. Later in the volume a chapter on devices for seeing, which might have been taken from a well-written elementary text-book on light, is followed by a chapter of detailed instructions in practical photography, reminiscent of the booklets of instructions given away with a camera outfit. Much of the book is interesting and well written, but it is doubtful whether the pupil will gain from the variety of material supplied that "elementary appreciation of those principles of science" which it is the author's object to instil.

(2) Mr. W. C. Dampier Whetham's volume (granting the existence of a class of non-scientific reader who is willing and able to follow the author in his strenuous course) is excellent. Here is to be found everything of importance which would be found in the pages of an elementary treatise on physics and chemistry, together with many things which could only be found in treatises which are far from elementary. No vital point is omitted, no difficulty slurred over, and though in scarcely more than 250 pages the author leads his readers from the very elements of mechanics to the highest flights of relativity and the quantum theory (taking in chemistry and bio-chemistry by the way), there is scarcely a subject mentioned on which valuable information is not given, and scarcely a point at which the author could fairly be charged with producing the illusion of knowledge without its substance.

"Matter and Change" is a miracle of condensation—to give a list of the subjects dealt with would be to court instant unbelief—and it is not to be expected that the book will be found easy of assimilation, in spite of the clarity of its style. It is not at the first or the second reading that the reader will extract all the marrow which it contains. We should like to see the book introduced into some of those non-scientific classes of schools for the benefit of which, in part, it has been written; expressing, however, at the same time the opinion that should any member of the class find himself thoroughly at home with it, his talents must have been seriously misjudged by his schoolmaster, and he should be transferred without delay to the science sixth.

Any reader who has mastered the contents of this little volume will have a systematic knowledge of physical science of which he will never have reason to be ashamed, and which many honours students in the university might envy him. But to master it he will have to read slowly, to re-read often, and, above all, to think hard. In spite of its brevity, it contains matter for more than one winter evening's entertainment.

J. A. C.

The People of Kilima Njaro.

Kilimanjaro and its People: a History of the Wachagga, their Laws, Customs, and Legends, together with some Account of the Highest Mountain in Africa. By the Hon. Charles Dundas. Pp. 349 + 16 plates. (London: H. F. and G. Witherby, 1924.) 18*s*. net.

KILIMA NJARO has had a varied influence on the history of East Africa. After its discovery by Rebmann in 1848, its problems and the incredulity with which European geographers received the statement that it is snow-capped led to several of the first European journeys into this part of Africa. The sentimental interest felt in the mountain by the German Emperor was one of the determining factors in the demarcation of the Anglo-German boundary. The relative accessibility of this mountain and the beauty

of its scenery has led to its repeated exploration. The latest contribution to its literature is a volume by the Senior Commissioner of Tanganyika Territory, Mr. Dundas, who states in the preface that study of the district and its people was compelled by the spell of the mountain more than by his own interest in research. His first chapter summarises the history of the exploration of the mountain and its glaciers, and reports that their rapid diminution in size since they were first mapped by Hans Meyer in 1887 and 1889 still continues. There is little direct reference to the geological structure and none to the interesting rocks of which the mountain is composed. The author makes for Kilima Njaro the surprising claim that it is the highest point of the British Empire!

The bulk of the work consists of a valuable account of the Wachagga, who live on the lower slopes of the mountain. One of the legends of this tribe refers to fire on Kilima Njaro, which is a possible reminiscence of an eruption; but the reference is so indefinite that it may be only a coincidence, and affords no evidence of recent volcanic activity. Mr. Dundas records various legends similar to the Bible account of the Fall of Man, of the story of Cain, and of the Flood. He is satisfied that these stories have been long known to the tribe, as they were told him by the older members, and if they had been derived from the missionaries they would doubtless have included some from the New Testament. The claim by Merker that the Masai folklore includes some Biblical stories has been distrusted; but the author considers that it is supported by his discoveries of the Chagga legends.

The two chief drawbacks in the book are the absence of references and the brevity of the index; various authorities are quoted in the text, and the reader might lose time in endeavouring to trace them, especially when the names are misspelt, as in the case of Kersten (p. 20). The index is inadequate and the illustrations are sometimes far from the reference to them in the text. Thus opposite p. 192 is a figure of a "Nungu" or "Cursing Stone" dug up from ruins of a fort of the former Chagga Chief Horombo. It is referred to on p. 174, but is not mentioned in the index. The specimen is strikingly like those in South Africa which have been called Kaffir digging stones. The author considers that it was used as the medium for conveying a curse which might be removed by the submission of the offender. The Wachagga are accomplished smiths, and sell their iron work to the adjacent tribes; they buy the metal from the Pare, a tribe living south-south-east of Kilima Njaro. The volume includes a series of Chagga proverbs and an especially valuable chapter on Chagga law and political institutions. It forms a useful addition to East African ethnology.

Our Bookshelf.

Nuovi orizzonti della psicologia sperimentale. P. Agostino Gemelli. Seconda edizione riveduta e aumentata. Pp. xiv+387. (Milano: Società Editrice "Vita e Pensiero," n.d.) 18 lire.

ENGLISH readers of these essays will be disappointed at the lack of reference to the work of the last ten years in psychology, and the book suffers from having neither bibliography nor index. But it is admirably suited by its lucid style and unbiassed criticism to the special purpose for which it was written, namely, as an introduction to experimental psychology for the use of Italian students.

In Italy, we are told, psychology has always been unduly influenced by philosophy. Whereas in Germany, England, and the United States, objective methods have been in the ascendant, experimental work has been discounted in Italy, where there are only two institutes (of Prof. Kiesow at Turin and Prof. Sante di Sanctis in Rome) for psychological research. "The field of psychology is invaded by philosophers, men of letters, dilettantes; people with the best intentions, who are always discussing general questions but have not advanced the science of mind one jot because they have never applied themselves to psychological research by strict methods and mental discipline."

The first essay discusses "Psychology as a Biological Science," and the inadequacy of biological explanation to solve psychological problems. Nevertheless, it is to Fechner, Wundt, and their successors that we owe the methods of experimental research by which mental activity can be described and studied. The second, on "Prejudices against 'Laboratory Psychology,'" insists that objective observation must be extended and reinforced by subjective, *i.e.* introspective, observation as described in the third essay, on "New Method of studying the Psychology of Will and Thought." Here the teaching of Ribot and Binet, and of Külpe at Würzburg, is contrasted with the earlier school of Leipzig.

"The Pathological Method in Psychology" is next considered, with a reminder that the relative and exceptional cannot be estimated as absolute and regular, and that psychology must not be degraded into psychiatry.

The concluding essay deals with "Psychology as the Science of Consciousness." Consciousness is a function of mental life (*vita psichica*) and not co-extensive with it—it is an autonomous synthetic activity. This theory is experimentally justified by recent researches into the origin of judgments and concepts along the lines of the school of Külpe. F. A. W.

Les Moustiques de l'Afrique mineure, de l'Égypte et de la Syrie. Par E. Séguy. (Encyclopédie entomologique, 1.) Pp. 257+29 planches. (Paris: Paul Lechevalier, 1924.) 50 francs.

ALTHOUGH the Culicidæ as a family are perhaps better known now than any other group of insects, our knowledge of all the details of their life-histories is still far from complete, especially as regards the species of certain regions. The author of the work under notice

of opinion that the mosquito fauna of North Africa and Asia Minor is less known than that of any other malarious region, which was certainly true until very recently. As shown by this volume, however, the deficiency is now to a large extent made good. The main title of the work is somewhat misleading, as it includes a fairly detailed account of nearly all the European mosquitoes, on the quite justifiable ground that many or most of them will be found eventually in the regions under consideration. The treatment is mainly from the systematic point of view, but larvæ as well as adults are discussed and distinguished, as is essential for practical purposes. The bulk of the text is a compilation from previous publications of the author and other workers in this field, but there are some 200 original and carefully executed drawings of structural details, which in themselves will render the work of much value to students. The author, like other systematists, to some extent follows his own inclination as to nomenclature and classification, but the views of others are made clear by full references. His attempt to divide the biting mosquitoes into three subfamilies is not very successful. There are a number of minor errors and inconsistencies, which appear to be chiefly due to too hasty compilation (compare, for example, the references to *Dixa submaculata* on pp. 177 and 179). The volume concludes with a catalogue of Palæarctic and Nearctic Culicidæ, together with a number of maps showing the distribution of some of the more interesting species; some of these, it must be admitted, are partly hypothetical.

Leitfossilien aus dem Pflanzen- und Tierreich in systematischen Anordnung. Von Prof. Dr. Johannes Felix. Zweite, neubearbeitete Auflage. Pp. vii+228. (Leipzig: Wilhelm Engelmann, 1924.) 7 marks.

This is undisguisedly a student's text-book of fossils. There is practically no discussion of phylogenetic relationships: the organisms treated of are arranged, not according to the formations in which they occur, but according to their presumed place in the systematic arrangement. The classification adopted can only be described as antique. Thus sponges are regarded as a division of Cœlenterata. Trilobites are regarded as "Crustacea," and a picture is given of an obscure and incorrect restoration of a trilobite by Jæckel, whilst the infinitely clearer and more correct restoration given by Beecher, the discoverer of the trilobite limbs, is ignored. "Ganoidea" is still recognised as a division of Pisces, and a phylum named "Vermes" appears. Fortunately, since fossils only are described, this is practically coterminous with Annelida.

These blemishes are, however, of less importance in a book which is evidently intended merely as a handy reference manual for elementary students. Very fair figures are given of the known structure of what might be termed "difficult" fossils. Thus we have sections of Nummulina, of Stromatopora, figures of some leading types of crinoids, a longitudinal section of the brachiopod Waldheimia, and of the lamellibranch Hippurites, and of the rod-like shell of the cephalopod Endoceras.

Of course, there are numerous illustrations of vertebrate fossils; but as showing the lack of modern information, we may refer to the skull of the stegocephalous amphibian shown on p. 164, where the covering bones are shown. The names given to these are those to be found in Huxley's "Vertebrata," published in 1871. We think that even in an elementary text-book the student should learn the terms actually in use at the present day. E. W. M.

Die spezielle Relativitätstheorie Einsteins und die Logik. By Dr. J. H. Tummers. Pp. 15. (Venlo, Holland, 1924.) 1*s*.

This pamphlet gives a clear account of the fundamental bases of Einstein's special theory of relativity from the point of view of the logician. The author reaches the conclusion, with which relativists no doubt will agree, that Einstein's fundamental postulates of relativity and of the constancy of the velocity of light are logically inconsistent with each other so long as the absolute character of simultaneity is insisted upon. Moreover, he agrees with Einstein in his further conclusion that the two postulates together require that simultaneity be relative, in so far as two events, which happen at the same time for one observer, happen at different times for another observer in uniform motion relative to the first. But he maintains that, because the two fundamental principles are themselves merely postulates, the conclusion that simultaneity is relative is not proved, but merely postulated, and consequently its acceptance fails to remove the original contradiction between the two fundamental principles. Thus, he argues, we must reject the principle of relativity, if we accept that of the constancy of light-velocity, and admit that simultaneity is absolute, as we did before the introduction of Einstein's theory, a procedure which is tantamount to rejecting that theory as out of touch with reality.

Relativists will scarcely accept the author's sweeping conclusions; they will prefer to adopt the three admittedly consistent postulates of relativity, constancy of light-velocity, and relative simultaneity, rather than reject Einstein's theory, which, after all, has been very successful in co-ordinating many experimental facts not explained satisfactorily by any other theory—an achievement which the author seems to ignore entirely.

A Course of Instruction in Instrumental Methods of Chemical Analysis. By Prof. W. N. Lacey. Pp. vii+95. (New York: The Macmillan Co.; London Macmillan and Co., Ltd., 1924.) 7*s*. net.

One of the difficulties experienced by students desirous of becoming acquainted with the technical analysis of materials is that the description of the apparatus employed is scattered throughout a voluminous literature. In this little volume an account is given of the principles underlying the use of instruments such as viscosimeters, pyrometers, refractometers, colorimeters, and so on, together with a clear statement of the utility and limitations of some of the types of apparatus. The sections are concise and to the point, and the practical work is well arranged. A valuable feature is the set of questions printed at the end of each section. These have been selected to bring out the essential features of the instruments and the value of the results to be anticipated from their use. A useful appendix

gives a list of materials and apparatus needed for each instrument.

Electrometric methods are now of such importance in practice that the section on "Electrometric Analysis" is to be welcomed as an introduction to the subject. In the reviewer's opinion, the pages devoted to "fire assaying" might well be omitted in favour of an addition to the description of electrometric measurements, particularly as the art of dry assaying is one requiring long experience.

The book serves as an excellent introduction to the subject, and is well worth the attention of students of chemical technology. J. J. F.

The Philosophy of "As if": a System of the Theoretical, Practical and Religious Fictions of Mankind. By H. Vaihinger. Translated by C. K. Ogden. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xlviii + 370. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1924.) 25*s.* net.

PROF. VAIHINGER'S work, now translated into English, has been well known by philosophers almost from its first appearance in 1911. The translation is made from the sixth edition of the original, specially revised by the author to meet the case of historical references which might be obscure to the English reader. The doctrine is that "'as if,' *i.e.* appearance, the consciously false, plays an enormous part in science, in world-philosophies, and in life." The basis of the theory is Kant's doctrine of the Ideas of Reason, God, Freedom, and Immortality. These Ideas, according to Prof. Vaihinger's reading of the Critique, are not objects of knowledge the existence of which, though it cannot be proved by pure reason, is a necessity of the practical reason. He holds, on the contrary, that they are conscious fictions, and that the condition of our human activity is that we must act "as if" they were true. The same principle he holds applies not only to Ideas of Reason but also to all the categories of the understanding, in fact throughout the realms of science and philosophy.

Electrode Reaction and Equilibria: a General Discussion held by the Faraday Society, November 1923. Pp. 665-838. (London: The Faraday Society, 1924.) 10*s.* 6*d.* net.

THE general discussions of the Faraday Society continue to fulfil the useful functions which give to that Society its unique position amongst bodies pursuing similar aims in various branches of science. The discussion on "Electrode Reaction and Equilibria" was held on November 26, 1923, in the very worst of conditions as regards weather, but was attended in person by Prof. Biilmann, of Copenhagen, and by Dr. Heyrovsky, of Prague, as well as by the most keenly interested workers in Great Britain. The permanent record of the discussion forms a volume of nearly 200 pages, and contains 18 original contributions on the two related subjects of reversible and of irreversible electrode reactions, which were the subject of consideration at the afternoon and evening meetings. It is impossible to summarise these papers in a brief note; but the usefulness of earlier issues of the series of reprinted general discussions is so well known, that no further commendation of the latest publication is needed to emphasise its value to all who are interested in the subject with which it deals.

Indian Philosophy. By Prof. S. Radhakrishnan. (Library of Philosophy.) Vol. 1. Pp. 684. (London: G. Allen and Unwin, Ltd.; New York: The Macmillan Co., 1923.) 21*s.* net.

WE have undoubtedly a vast store of wisdom in the systems of Indian philosophy, and many Western philosophers in the modern period, from Schopenhauer to the Rhys Davids, have drawn inspiration from it. It differs, however, in one very essential particular from Western philosophy, both ancient Greek and modern. It aims at setting our questioning activity at rest by offering us satisfying answers to our problems; it does not stir up in us the restless Socratic spirit of inquiry. The emphasis is on what has been thought out and solved by seer and sage. The study of Indian philosophy, therefore, resembles the study of authoritative religious systems and is unlike the methodology in which our philosophy so largely consists. Prof. Radhakrishnan presents his subject in the form of an encyclopædia of systems. It is a continuous history and also specially useful as a book of reference.

An Introduction to the Practice of Civil Engineering. By E. E. Mann. Pp. xi+296. (London: Macmillan and Co., Ltd., 1924.) 7*s.* 6*d.* net.

THE author's object in preparing this volume has been to render easier the period through which young men have to pass after leaving college. This period is often exceedingly trying, both to the beginner and to those who have to look after him in the civil engineer's office. He may have had a very successful college career, and the work he will most certainly be started on is usually of such a character as to lead him to imagine that a great part of his studies have been useless. Of course this view is quite a mistaken one; responsible work will come later, and the knowledge acquired in college will then be essential to success. The volume before us will be of great service in bridging over the transition period, and we can heartily recommend it to students still pursuing their college course, in order that they may have some idea of what lies before them when they are introduced to the practical work of the civil engineer.

A School Mechanics. By C. V. Durell. (Cambridge Mathematical Series.) Part 1. Pp. xx+186+x. (London: G. Bell and Sons, Ltd., 1924.) 3*s.* 6*d.*

MR. DURELL'S complete work is intended to cover the course required for the School Certificate and the various matriculation examinations. The part before us contains an easy introduction to the subject which should be successful in awakening the interest of the student; its contents are restricted almost entirely to vector quantities located in the same or parallel lines, and cover velocity, acceleration, moments, work, machines, energy, momentum, and the relation of force with acceleration. Gravitational units are employed in the treatment. The author has taken pains to make his subject alive, and the book will be welcomed in such secondary schools as include the systematic teaching of mechanics in their course of work.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Luminescence of Solid Nitrogen and the Auroral Spectrum.

In a paper recently published in Proc. Roy. Soc. A. 106, p. 138, Prof. McLennan and Dr. Shrum give results showing that they have been able to reproduce the same luminescence effect in solid nitrogen which I discovered in January last and foretold in my earlier papers on the auroral spectrum. In their discussion of the results, however, they come to the conclusion that this effect is not applicable to the auroral spectrum.

In order to meet the argument put forward it would indeed be sufficient to refer to my previous publications,[1] from which it appears that the conclusions drawn by McLennan and Shrum are contrary to observed facts; but as their paper might give the impression that they had found new facts which disproves my interpretation of the auroral spectrum, and as their paper also, in my view, contains some other errors, a few comments upon it seem to be necessary.

First of all, it should be made clear that our difference of opinion does not originate from a difference with regard to experimental facts. As already mentioned in my previous papers, the luminescence of solid nitrogen shows two bands in the green, called N_1 and N_2. While N_2 has the appearance of a single diffuse line, N_1 has the form of a band showing three maxima, one strong ($\lambda = 5555$) and two weak ($\lambda\lambda = 5611$, 5649). McLennan and Shrum find the same two bands and with the same structure. For the three maxima of N_1 they give the wave-lengths 5556, 5617, 5654, in good agreement of my own values. The band N_1 extends on both sides of the auroral line (5577); but this line does not coincide with any of the maxima of the band N_1.

Now McLennan and Shrum *regard the three maxima of the band N_1 as ordinary spectral lines with a definite wave-length*, and, as the auroral line does not coincide with any of them, they regard it as proved that the band N_1 has nothing to do with the auroral line. The matter, however, is not so simple, and these two investigators do not seem to have realised that we are dealing with a light effect of a peculiar type. Their conclusion, which usually would hold for spectral lines originating from a gaseous source, is not valid for the light effect in question, which is emitted from matter in the solid state.

As a matter of fact, I have been able to show that this light effect is attached to some special crystal structure of nitrogen and that *the maxima of the band N_1 have no definite positions, and hence they cannot, as is done by McLennan and Shrum, be treated as ordinary spectral lines.*

My view is that the band N_1 is a manifestation of the same effect as that which is responsible for the auroral line, which is to be regarded as the limiting aspect of this band when the particles are reduced to molecular order of magnitude. The correctness of this view is strongly supported by the results of my experiments with mixtures of nitrogen and argon.

So long as we are unable to reproduce the conditions of the upper atmosphere, we cannot apply to the band N_1 the ordinary spectroscopic method of identification by means of exact wave-length measurements. It is possible, however, to test the correctness of my view by taking into account the whole auroral spectrum and by drawing evidence from the various cosmic phenomena connected with the upper atmosphere, and—as will be seen from my papers—my conviction of the correctness of my interpretation of the auroral spectrum is gained in this way.

In dealing with the auroral spectrum we must, above all, take into account the type and the intensity distribution of the lines. The error which we find in so many earlier attempts at interpretation is that due attention has not been paid to the *spectrum as a whole*. In spectral tables a number of lines were found, which, within the limits of possible errors, coincided with auroral lines, regardless of the question as to whether the lines so picked out formed a connected physical system and could exist as a light effect from one single source. We should not only consider the lines which actually appear in the auroral spectrum, but also regard those, often equally important, which *are not present*. Now solid nitrogen bombarded with cathode rays constitutes a simple physical system which just gives the most singular type of spectrum which is found for the auroræ, and also explains the predominance of the auroral line. McLennan and Shrum suggest that the experiments show that N_2 ought to come out stronger in the auroral spectrum than it actually does. This, however, is not so, for, as my experiments show, N_1 may be made to dominate the whole spectrum, and, under the conditions existing in the upper atmosphere, we should from my experiments expect the auroral line 5577 to be quite predominant as compared with 5230.

McLennan and Shrum are also mistaken in regard to their interpretation of the luminescence from solid argon. Thus their statement that they have found a phosphorescence with an afterglow in pure argon is not in accordance with my experiments. The green afterglow usually observed was shown to be due to minute traces of nitrogen, and the phosphorescence line was identical with N_2. Further, they regard the strong diffuse line 5607 as an argon line; but this line is no doubt the same as 5604 of my experiments, and this line was shown to be the N_1 band of nitrogen in a somewhat different position and in a transformed state. The correctness of my view was evident from the analysis of the light effect from mixtures of argon and nitrogen of varying concentrations.

Also the view taken by McLennan and Shrum with regard to the physical conditions for producing the N_1 band is contrary to my observations, details of which will be found in my papers.

In conclusion, it is perhaps worth while to suggest that differences between McLennan and Shrum's observations and my own may be partly due to the fact that their experimental material was very limited, and that their arrangements made it difficult to overlook the experimental conditions and to vary them in a known way. Instead of bombarding a layer of solidified gas with a well-defined bundle of electric rays—as was done in my experiments—they have formed the layer on the walls of the discharge tube itself, which was wholly surrounded with the cooling liquid.

L. VEGARD.

October 15.

[1] Proc. Roy. Akad. Amsterdam, 27 *C.R.* 178, p. 1153; 179, p. 35, and p. 157. NATURE, vol. 113, No. 2846, p. 716, and vol. 114, No. 2862, p. 357.

Interpretations of Primitive American Decorative Art.

My friend Mr. G. C. Robson, the gifted malacologist of the British Museum (Natural History), has taken me to task in NATURE of September 13 over the interpretation of the Mayan sculptures which I ventured to make in the issue of August 2. Writing as a zoologist he has censured my communication more leniently than I should have done were I criticising it from the same point of view.

Mr. Robson avers that I am inaccurate in stating that in the argonaut and the Bathypolypus the two central arms are often so closely apposed as to appear a single very broad tentacle. During the writing of my communication (in April last) I examined and roughly sketched, both in the Reading Room and in the Mollusca Gallery of the British Museum, drawings and specimens of various Cephalopoda. I am to my regret unfortunately unable to give him, as I should like, specific references to these sources of information, as they have been destroyed, and being now invalided to my room, I am precluded from visiting London to re-examine them. Mr. Edge-Partington, however, well known for his album of primitive decorative art, with whom I have throughout discussed this question, agreed with me in seeing in my memoranda a broad trunk-like tentacle by the apposition of two others. If memory serves, my note on the argonaut was made in Mr. Robson's gallery at South Kensington. I am not a malacologist, and my assignation of the tentacles to a "central" position is doubtless (since Mr. Robson says so) morphologically inaccurate; but that has little or no bearing on the identification of the *motif*.

Mr. Robson nevertheless admits that the Manabi slab "looks like a conventionalised squid," but he asks: If a squid, why eight arms? And what is the meaning of the tufts on the mantle and of the circular ends of the arms? My friend has gone astray in looking too malacologically at these Mayan designs. He forgets that the Central American sculptor did not work on a zoological subject for exhibition at the R.A., or for a scientific diagram. He was a *decorative* artist with extensive spaces to adorn, while his chief aim was to depict gods of terrifying aspect.

I remember well, when a boy, searching on a beach of the North Sea for upcast treasures after a gale, the finding of a creature unknown to me, whose enormous immobile eyes and long arms studded with suckers made a lasting impression on me, and especially my astonishment when, on dissecting it, a parrot's beak was prominently disclosed which I concluded the creature had choked upon! If I were now, after sixty years, asked to sketch my recollection of this "cuttle-fish," the serpent-bird panel from Tikal (Fig. 2 of my letter August 2) would closely fit my impression of my first cephalopod. The Mayan sculptor had perhaps recalled, in his work, a vivid and more terrifying experience with one or other of the monsters of this family, or he may not improbably have worked on lines handed down to him from ancestor artists who knew such a creature too intimately.

In my letter of August 2, in trying to look at the sculptures through the Mayan artist's eyes, I made suggestions as to features of more than one cephalopod family to fix the true basis of his *motif*. None of the Mayan designs represents any one species, but here one and there another suggestion from different groups seems incorporated in the artist's scheme, but the *motif* of them all—not only of those I alluded to in my letter, but of numerous decorative designs on structures, to which space did not allow me to allude on August 2, throughout ancient Mexico—is in my opinion based on members of the Cephalopoda, incorporating likely enough the indigenous parrot, but none based on elephant trunks. The sculptor had to get in what impressed him most—eyes, tentacles, and especially prehensile suckers.

In the decorative craftsman's method of work it is of no consequence whether the arms are of the proper number, or the eyes, mouth, or suckers are anatomically correct as to position. He relied in his work on a "most generalised conception" as all primitive decorative artists do. He was not tied to anatomical details; he took from or added to his mental prepossessions as suited his space and his caprice; realism meant nothing to him. May I recall to Mr. Robson the frigate-bird design in New Guinea. "One may see designs," as Mr. Henry Balfour very aptly words it (*Journal Soc. Arts*, 1896), "representing the frigate-bird in all stages between very fair realism and complete conventionalism—tending towards a purely meaningless pattern whose resemblance to a natural object has entirely ceased. . . . *The tendency is for the more important portions of a symbolic design to persist while the rest may disappear*" (my italics).

A still more suggestive example is that figured by Mr. Edge-Partington in *Man* (1902, 17), where a lizard (or other animal) is carved realistically moving on its legs with its tail coiled in a spiral; but later we find the design on a large panel degenerated to a conglomeration of spirals overspreading it, and wherever a vacant space—so abhorred by decorative artists—occurs too small for spirals, it is filled in by an endless series of the animal's legs. The cephalopod design in Mexican decorative art—of the Stela B period—was approaching the same stage as these frigate-bird and lizard designs. The tentacles and suckers—the most important portions of the symbolism—were repeated wherever they could be inserted. The Mayan artist, however, did not, as Mr. Robson suggests, throw "the structure of his model entirely to the winds," for the designs in the lower register at each corner of Fig. 3 (letter of August 2)—which of course is only half the panel—and especially the design on the back of Stela B, Fig. 7, are realistic cephalopods which I leave Mr. Robson to name. What relation can they possibly have to an elephant, and why introduced if they have no relation to that *motif*? And why are the coiled arms on Stela B, regarded by Mr. Robson as "structures that look like a tusk [of an elephant]," provided with suckers?

If in April I had possessed Prof. Elliot-Smith's "Evolution of the Dragon," I could have condensed considerably my letter in NATURE of August 2 (which rather taxed the valuable space at the disposal of the Editor), for I could have cited the extraordinarily illuminating figures (23, p. 172, and 24, p. 180) in that volume for pictorial support to my theme. In these pictures Mycenæan and Ægean potters, doubtless impressed, as were the American sculptors, with the staring eyes and the cusp-studded tentacles of cephalopods of their own seas, have pictured them in almost identically the same manner as the Copan sculptors have done. Mr. Robson will see there even circular ends to the octopus arms, about which he makes inquiry. He should also compare my Fig. 7 (August 2) with Elliot-Smith's Fig. 23 (*op. cit.*). "The position usually adopted by the resting octopus" which that author reproduces (after Tryon) on Fig. 22 supplies speaking suggestions for the cusp-studded tentacles surrounding the top of Stela B, of which two to fill suitably its front top edges, recalled from some gigantic species of the western seas, have been too confidently assumed to be elephant trunks.

Elliot-Smith's plates, 23 and 24, are interesting
fm another point of view. The Mediterranean
a ists have employed a strikingly similar method of
r esenting the octopus as the Mayan quite *inde-*
endently of each other, and at two far separated
l alities. This fact gravely invalidates the moral
p nted by the dogmatic sermons of Prof. Elliot-
S ith and his disciples, if I understand them, that
v thout contact no two minds have ever independ-
e tly "brought forth similar products whether in
s ial organisation, religion, or material culture."
] Egypt "and nowhere else" did inventions
o ginate! It is surprising that with his own plate
b before his eyes Prof. Elliot-Smith failed to recognise
t e clue to the riddle of the Mayan indigenous sym-
l lism, but wildly stumbled on so exotic a *motif* as
a mahouted elephant's trunk in America.

HENRY O. FORBES.

Deanway, Beaconsfield, Bucks.

Active Nitrogen.

PROF. R. T. BIRGE states in his letter appearing in
NATURE of November 1, p. 642, that "active nitrogen
was discovered in 1900 by Prof. E. P. Lewis, . . . and
was found by him to have a characteristic spectrum."
I dislike discussions about priority, but can scarcely
avoid pointing out that the expression "Active
Nitrogen" was coined by me to express the facts
which I discovered in 1911—namely, that a stream
of nitrogen in a peculiar state is able to react in the
cold with certain metals to produce nitrides, with
carbon compounds to form hydrocyanic acid, and so
on. This was established by purely chemical methods.
The luminous phenomena which gave the clue to this
discovery were described by Prof. E. P. Lewis, and I
was careful to make due reference to his work.

RAYLEIGH.

Terling Place, Chelmsford,
November 5.

The Mass-spectra of Cadmium, Tellurium, and Bismuth.

I HAVE now succeeded in obtaining and analysing
the mass-rays of cadmium, tellurium, and bismuth.
By the use of an anode containing cadmium fluoride,
rays were obtained which, though feeble, gave satis-
factory results with long exposures and the most
highly sensitised schumannised plates. Cadmium is
a very complex element, having six isotopes: 110 (c),
111 (e), 112 (b), 113 (d), 114 (a), 116 (f). The last is
isobaric with the lightest isotope of tin. The in-
tensities of the lines are in the order of the letters
and agree reasonably with the chemical atomic weight
112·41. The most striking characteristic of the group
is its remarkable similarity to that of tin. If we
except the heaviest isotope of tin (124), which does
not seem to have its counterpart in cadmium, the
intensity relations between the isotopes of the two
elements appear almost identical. This is a most
suggestive fact and may have a deep significance in
connexion with the relative stability of the nuclei of
isotopes. The plates are not very favourable for
accurate determinations of masses, but these seem
integral with that of iodine.

The line of the latter element was extremely faint
in these experiments, so I considered it a favourable
opportunity to make another attempt on tellurium,
which had defied all attacks during the earlier dis-
charge tube work. A little pure metallic tellurium
was ground into the anode mixture and success was
at once obtained. Tellurium gives three lines of
mass numbers—126, 128, 130. The intensities of the
two latter appear about equal and double that of the
first. I have repeated this result with an anode
containing tellurium and lithium fluoride, and have
no reason to doubt that these are all genuine isotopes.
Comparison with other lines on the plates suggests
that their masses may be less than whole numbers by
one or two parts in a thousand, but it seems probable
that the mean atomic weight is actually greater than
128, whereas all the later chemical determinations
are less than that figure, the accepted value being
127·5. The element tellurium is unique among those
so far analysed, as it seems probable that *all* its mass-
numbers form members of isobaric pairs. These are
shared by xenon, the element of next higher even
atomic number.

The boiling-point of tellurium is not very different
from that of bismuth, so that it seemed possible that
the latter might yield to the same treatment. This
hope was realised with an anode containing metallic
bismuth, and a single line appeared in the expected
position—209. This line is very faint, and owing to
the great mass lies in an unfavourable part of the
plate, but there seems no reason to doubt that
bismuth is a simple element of mass number 209, as
recent determinations of its atomic weight suggest.

F. W. ASTON.

Cavendish Laboratory, Cambridge,
November 4.

Need for the Redetermination of the Atomic Weights of Uranium, Thorium, and Radium.

IT is known that the atomic weights of such radio-
elements as have been determined experimentally
agree approximately with those to be expected on
radioactive theory, and also that small unexplained
discrepancies appear when the actual instead of the
approximate values are considered. The simplest
explanation of these small discrepancies is, I think,
that one at least of these determinations is wrong,
and I give reasons below for this view in the hope
that someone versed in atomic weight work will
make fresh determinations of the masses of the
elements concerned.

The following are the experimental values of the
atomic weights to be discussed: uranium, 238·18;
thorium, 232·15; radium, 225·97; radium Ω′,
206·04; thorium Ω, between 208·0 and 208·2. If
the atomic weight of radium Ω′ be accepted as 206·04,
that of radium should be 226·08 and that of uranium
238·09, assuming that the α-particle has a mass of
4·00, and allowing for the loss of mass due to the
energy of the expelled particles. Each of these
values is nearly 0·1 different from the experimental
values. If the allowance for the loss of mass be
neglected, the calculated value for radium is within
the error of the experimental value, but the calculated
value for uranium is 0·14 smaller than the experi-
mental. Several workers, including the writer, have
preferred to accept this second view and to explain
the discrepancy between uranium's calculated and
experimental values by assuming the existence of an
isotope with a greater mass than that of uranium.
The new contribution to this discussion is that this
will not account for the discrepancy. Such an isotope
would reveal itself by its product, and it is now known
that the experimental evidence, while favouring the
existence of this isotope, is against its concentration
in ordinary uranium to an extent that would raise
the mean atomic weight more than 0·03. The close
relation between groups of radioactive isotopes and
those of inactive elements, lately pointed out by the
writer, leads also to this view. It would therefore

appear that if uranium's atomic weight is 238·18 the mass of uranium 1 is at least 238·15. This implies that in the transformations between uranium 1 and radium Ω′ a mass of 0·11 is lost in addition to the mass of the eight α-particles expelled. Whatever be the reason for this, it is probable that this small mass would be lost gradually, *i.e.* that ionium's mass would be about 230·13, radium's mass 226·11, and so on. This suggested value of radium's mass is greater than the experimental value by 0·14.

If the atomic weight of thorium is 232·15, this is also the actual mass of the radioelement thorium, for any existing or possible isotopes of greater mass-number are or would be β-ray bodies, and therefore of periods so short that their concentration in ordinary thorium could not affect measurably the mass of the principal constituent. The work of Prof. Joly on thorium haloes established in 1917 the absence of any very long-lived isotope of thorium, and confirms from an independent source this view. On present atomic weight evidence, then, there appear to be two bodies the masses of which are in excess of integers by about 0·15. So far mass-numbers in excess of integers have not been found by Dr. Aston among inactive elements. The mass of thorium Ω is uncertain to about 0·2, owing to the fact that no pure specimen of this isotope has yet been isolated.

The value of thorium's mass need have no bearing on those of uranium and radium, since thorium is a member of an independent series, unless we choose to assume that the rule discovered by Dr. Aston for the isotopes of several elements and, in particular, for those of tin, applies to the radioelements also. This rule is that differences in the masses of isotopes are approximately integral even when the masses themselves are not. Applied to thorium and ionium, it suggests the latter's mass is 230·15 if the former's mass is 232·15. This leads to masses of 238·15 and 226·15 for uranium and radium respectively. The former is within the experimental error of the accepted atomic weight, the latter is 0·18 too high.

It is, of course, obvious that there are too many uncertain factors at present to justify basing any conclusions upon these small differences. But there is a *prima facie* case, I hope I have shown, for the need of a redetermination of the atomic weights of uranium, radium, and thorium.

A. S. Russell.

Dr. Lee's Laboratory,
Christ Church, Oxford,
October 22.

A New Drift Indicator.

In connexion with research on fishery problems many investigations have been undertaken to throw light upon the water movements in the North Sea and other areas.

Schematic pictures of the current regime have been obtained in various ways, for example, by studying the isohalines of salinity distribution charts, by making direct observations of the currents by means of various instruments (current-meters, log-ships, etc.), and by setting adrift floating objects and noting where they are recovered. Each method has its obvious merits and demerits, but, when all things are considered, the use of drifting objects (usually bottles containing questionnaire papers) yields, without doubt, the most useful results for the purposes of those engaged in fishery research. The bottles are put out at a selected position, and the charting of the places where they are recovered is a relatively simple matter. The information obtained is very valuable, but it does not give the actual set away from the position of liberation.

Attempts to estimate this by means of current meter observations necessitate the computation of the residual current after the elimination of the tidal stream values from the observational data, and, in order to obtain any trustworthy knowledge of the residual currents as a result of direct measurements, considerable amount of data is absolutely necessary. Moreover, the resulting calculations are very laborious —at any rate this is the case with any instrument known to me.

An attempt has recently been made at this laboratory to devise an instrument which will yield the necessary information as to residual currents without exhaustively intensive measurements or laborious calculations. The instrument combines certain features of the well-known Ekman current meter with others of the Robinson anemometer (Fig. 1).

A set of cups which rotate when the instrument is lowered into the sea, are connected through certain gearings with an arrangement which releases phosphor bronze balls from a hopper, and allows the balls to roll down a groove on a specially shaped pivoted

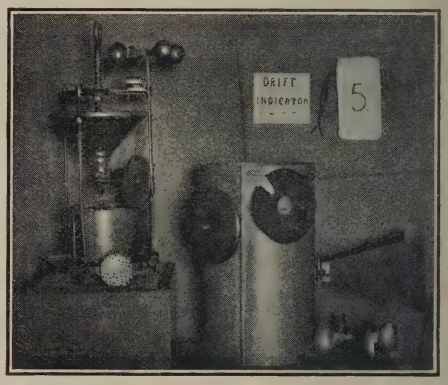

Fig. 1.—Drift indicator. To ensure that the instrument shall remain vertical when suspended in a tideway, the vanes are now shipped at the top of the cover and their after end is provided with an inclinable plane which enables the desired object to be effected.

magnet and so into a divided chamber. This chamber during the course of observations is orientated according to the current—the whole instrument being kept "in the current" by means of a vane on the cylinder which encloses the working parts. The hopper may hold many thousands of balls. The instrument which has been tested has been found to use about 700-800 balls per diem.

I am indebted to the Elder Brethren of the Trinity Corporation and to their Superintendent of the Great Yarmouth depot (Capt. G. T. Thompson) for the opportunity of carrying out the necessary tests on the St. Nicholas light-vessel which is situated about 1¼ miles off Great Yarmouth. The instrument can be worked quite well by the personnel of a light-vessel, and the results given below were obtained when the indicator was left down for 24 hours in the charge of the mate of the lightship named (Mr. T. Jay).

The sectors in the divided compartment (Fig. 2) are 20°, and the figures denote the numbers of balls in the various sectors.

The use of ordinary traverse tables enables one easily to resolve the values (numbers of balls) along the four cardinal directions and to find the magnitude and direction of the residual current if the "mileage value" of the balls be known. Calibration against log-ship observations showed that 24 balls were dropped for each mile of water that passed the ship. The necessary calibration was not an easy

natter at the time of the test. The movements of the ship at the time were not such as would allow the instrument to be kept near the surface without the risk of it being over-ridden and damaged. It was therefore used at a depth of about 7 fathoms. The log-ship time gave the rate of the surface stream, which rate was assumed to be also that of the water at 7 fathoms depth (though only pending further opportunities of testing the instrument near the surface).

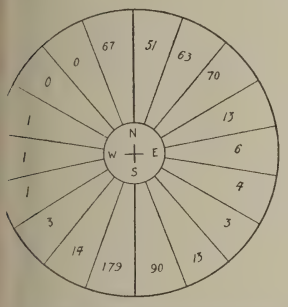

FIG. 2.—The distribution of balls in the compass box after a test of 24 hours ending 10.25 A.M., October 18, 1924.

Since the rate at the depth worked is certainly less than at the surface, it follows that the conversion factor used (24 balls per mile) is too low, and that the magnitude of the residual current calculated is too high, although the direction is correct.

The above data yield the following approximate maximal value for the residual water movement or drift :

$\frac{1}{2}$ miles per 24 hours in the direction S *ca.* 50° E. mag.

This drift indicator can be adapted to drop balls with varying frequency, and it can be left down for any length of time depending upon the size of the hopper chosen. Improvements in shape and size are to be carried out, and it is hoped that it will be possible to add considerably to our present knowledge of the water movements in areas of interest.

J. N. CARRUTHERS.

Ministry of Agriculture and Fisheries,
Fisheries Laboratory, Lowestoft.

The Resonance Theory of Hearing.

IN reference to the recent letters of Prof. Scripture and Mr. J. Keen which have appeared in NATURE under the above heading, it seems to me that the opponents of the resonance theory rely rather too much on the assumed inherent absurdity of the theory. It is a theory which has been, and is, held by a considerable number of people whose judgment in the matter is deserving of, at all events, some consideration.

In drawing analogies from the other sense organs, Mr. Keen should bear in mind that the nature of the analysis required of them to furnish accurate information to the brain is different for each sense. To say that the retina does not analyse white light into its constituent colours is to assert what is by no means proved. It is certainly true (fortunately for our vision) that the retina does not separate these constituents of white light spacially, but that an analysis of the waves of light according to frequencies does occur is an assumption essential for the explanation of colour vision. It is generally believed that this analysis takes place in the retina and not in the brain. The analogies between tone analysis by resonance and colour vision may indeed be carried much further.

Mr. Keen's example of the senses of heat and cold seems scarcely applicable. Here temperature represents intensity, and is perceived as such. Intensity is, of course, an attribute of all sensation.

The recognition of the basilar membrane as a resonating organ is based on the regular gradation of the differentiation of its parts for length, tension, and mass, between very wide limits. So marked is this gradation, that there is no inherent absurdity in the belief that it is sufficient to account for a range of action corresponding to the audible scale, say eleven octaves. The elaboration of this differentiation is unexplained either by the telephone or the pressure pattern theory. Indeed, the differentiation that one recognises in the cochlea is sufficient to preclude entirely the possibility of such "simple" modes of action. It is better to explain the function of an organ in terms of what is actually present than to devise theories as to how it may act in spite of what is known of its structure. GEORGE WILKINSON.

Polarised Light and Starch Content of Plants.

NEARLY two years ago (NATURE, January 13, 1923, p. 49) I was able to describe the acceleration of hydrolysis of starch under polarised light *in vitro*. It may be of interest to record that I have succeeded in confirming these results in the living plant.

Under artificially polarised light, the starch in the plastids, both in the guard-cells and in the leaf-tissue, has been shown to diminish, and the appearance in its place of a reducing substance has been demonstrated. In ordinary sunlight the starch content was increased, and in darkness the quantity remained unchanged. It is hoped to publish a full account of these experiments in the near future.

I wish to express my thanks to Prof. Neilson Jones, and to Prof. Lloyd, of McGill University, for helpful advice and criticism; also to the latter for kindly placing the facilities of his Botanical Department at my service, thus enabling me to benefit by the blue skies of Canada.

E. SIDNEY SEMMENS,
Amy Lady Tate Scholar of
Bedford College, London.

The Forces which lift Aeroplanes.

PROF. BJERKNES, in his Royal Institution lecture (NATURE, September 27, p. 472; October 4, p. 508), introduces the phenomenon of "acoustic repulsion" before going on to the accepted circulation theory of aeroplane lift. Both these are discussed in Rayleigh's "Collected Papers," Nos. 52 and 53 respectively; "Note on Acoustic Repulsion" (*Phil. Mag.*, 1878, also 1902, 1905), and "On the irregular Flight of a Tennis Ball" (*Mess. of Maths.*, 1877).

The former paper shows that the mean pressure in the interior of the cavity of a resonator is in excess of the external atmospheric pressure by the essentially positive quantity $(2\gamma t)^{-1}\int(p_1/p_0-1)^2dt$. The latter establishes, for the first time, the relation, Lift = Circulation × Velocity, a quantity which may be either positive or negative.

There does not seem to be any very close analogy between the two phenomena. A. R. LOW.

London, October 25.

The Technique of Contraception.

I VERY much value the discriminating and appreciative review by Sir Archdall Reid in NATURE of October 25, p. 601, of my book "Contraception (Birth Control), its Theory, History and Practice."

About the general technique of contraception, Sir Archdall is so kind as to say: "Dr. Stopes's experience . . . is so extensive that her opinions must necessarily carry weight." For this reason I must beg the courtesy of your space to correct his criticism that my views on cervical interlocking are a "belief." On the contrary, they are based on direct observation at the Clinic of more than forty cases. Further details will be given in the report on the first five thousand cases at the Clinic, which we are at present preparing. MARIE C. STOPES.

Givons Grove, Leatherhead, Surrey,
November 6.

Dust in the Atmosphere.

IT is to be hoped that the publication last year of the collected works of John Aitken has led many physicists to renew their acquaintance with his writings. The main features of his work are widely known, but it is not so generally recognised that on a number of points which are still obscure, he has many suggestive observations. In 1880, without knowledge of the earlier work of Coulier, Aitken discovered the nuclei of cloudy condensation in the atmosphere. For nearly forty years he continued to make observations on these nuclei, which he generally referred to as "dust." He devised and constructed various forms of dust-counter,

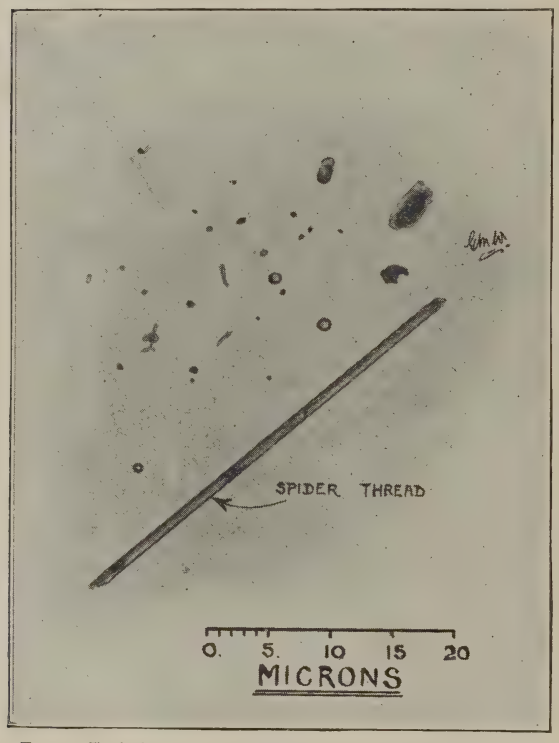

FIG. 1.—Typical smoke fog particles compared with a portion of an ordinary spider's web.

Reproduced, by permission of the Controller of H.M. Stationery Office, from the Ninth Report of the Committee for the Investigation of Atmospheric Pollution.

all characterised by ingenuity and mechanical skill of a high order, but most of them somewhat difficult of successful operation by any but the expert hand of the inventor. In his later years, writers on "large ions" caused him some uneasiness. He feared that the rôle of nuclei of cloudy condensation was being taken from his dust particles and attributed to some bodies of an electrical origin. But this fear was unfounded; what was suggested was that a certain number of Aitken's nuclei are charged and that these are the large atmospheric ions discovered by Langevin.

If this identification is correct, and it can scarcely be doubted, then we possess a considerable amount of information about Aitken's nuclei. His own work gives copious observations of the number of these bodies found under different conditions, while the experiments on large ions give us some clue as to their form and constitution. We may first note the very high values for the concentration of nuclei found by Aitken. In cities such as London, Paris, and Glasgow he obtained values of the order of 100,000 to 400,000 particles per c.c. In the pure air of the Scottish Highlands and in Switzerland his values frequently came down to a few hundred per c.c., but even on the Rigi Kulm he has observations of more than 15,000. The electrical observations on large ions suggest that the particles are, for the most part, of uniform size. If it be assumed that in the atmosphere each nucleus does not normally carry more than one electronic charge, and there is good reason for believing that this assumption is correct, then the diameter of the nucleus should be about 10^{-5} cm. The great numbers in which these bodies are found, their small and regular size, and the fact that they are produced so copiously from such a source as a Bunsen flame, suggest that they are not dust in the ordinary sense, that is, not irregular fragments of solid matter. Their behaviour and the manner in which they are produced indicate rather that they are spherules of water, each formed about some kind of primary nucleus, very often of a hygroscopic character. Assuming that the greater number of Aitken's nuclei are so constituted, in what form does the grosser mechanical impurity exist in the atmosphere? The answer will be found in the very interesting report of the Advisory Committee on Atmospheric Pollution referred to below.[1]

Three methods of estimating atmospheric impurity, representing successive stages in the development and improvement of methods of observation, have been employed by the Committee. In the method longest in use, the material precipitated by rain or otherwise on a standard area is collected. The monthly deposit is measured and analysed as soluble and insoluble, tarry, carbonaceous, sulphate, chloride, etc. The original gauges employed for this purpose were made of enamelled iron and did not prove resistant to atmospheric action. A new pattern constructed of stoneware has been employed and found satisfactory. It appears from the report that in the year which ended on March 31, 1923, there was a distinct improvement in the purity of the atmosphere as compared with the average of previous years. At 23 stations out of 27, the total solid deposited was lower than the normal, while the rainfall on the whole was about average. It is interesting to note that, comparing the deposit of chlorine in summer and winter, 19 stations show a higher figure for winter. This is in accordance with the view that the chlorine in the atmosphere is derived from sea-spray, the rougher seas in winter furnishing greater quantities of spray.

In the second method of observation, an automatic record is obtained on a sheet of filter-paper of the dusty impurity of the air by Dr. Owens' apparatus. From two to four samples of dust can be obtained per hour, and thus the variation in the impurity of the air can be followed through the twenty-four hours.

[1] Meteorological Office: Air Ministry. Advisory Committee on Atmospheric Pollution. Report on Observations in the Year ending March 31st, 1923: Forming the Ninth Report of the Committee for the Investigation of Atmospheric Pollution. (M.O. 260.) Pp. 59. (London: H.M. Stationery Office, 1924.) 4s. 6d. net.

Some striking records are obtained by means of this instrument. At night the air is very pure. In the early morning, earlier in summer than in winter, the

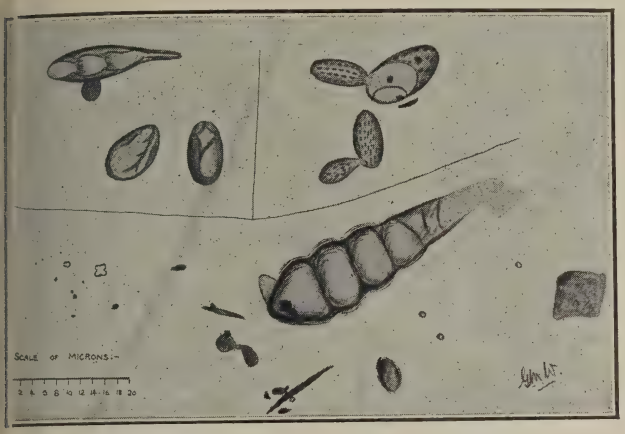

FIG. 2.—Organic particles of definite structure, collected from the air of Cheam, Surrey, on January 29, 1923, by means of the jet instrument. Reproduced, by permission of the Controller of H.M. Stationery Office, from the Ninth Report of the Committee for the Investigation of Atmospheric Pollution.

pollution recorded at the London stations increases rapidly, maintains a fairly high figure during the day with indications of a subsidiary minimum about 9 o'clock, and then falls off in the late afternoon. Here we note a distinct difference between the true dust and the Aitken nuclei. It does not appear that either Aitken or Barus, who did much work on the subject in America, took records of nucleation during the night. But it is clear from the observations of M'Clelland and Kennedy in Dublin that the large ions, that is, the charged fraction of the nuclei, are not noticeably fewer at night than during the day. Apparently the relatively large particles of true dust coagulate rapidly and are quickly deposited. The nuclei of Aitken are more persistent, but it is nevertheless surprising that, when their production has ceased, and when the air is being renewed rapidly on windy nights, they should not show a marked decrease. The dustiness shown by the automatic recorders in London is greater in winter than in summer and greater on foggy than on clear days. While in summer the atmosphere is cleaner on Sunday than on other days, there is no difference during the winter. The inference is that the greater part of the pollution in London is due to ordinary domestic fires. The same result is found to hold for the residential districts of Glasgow.

Much the most interesting part of this report is the record of results obtained with the jet dust counter. With this apparatus, the impurity in a limited quantity of air, say 50 c.c., is thrown on a glass slide, where the particles may be counted and scrutinised microscopically. The dust consists largely of irregular particles of a crystalline character, but occasionally organic bodies of a definite structure are found. A good idea of the appearance of the dust may be gathered from the illustrations, some of which are here reproduced (Figs. 1-3). The particles are of various sizes from 1 or 2μ down to the limit of visibility. A puzzling feature of some of the samples obtained has been the presence of transparent spherical bodies, for the origin of which no satisfactory explanation has as yet been obtained. Crystals of sodium chloride have been found in the air near the sea-shore, and other hygroscopic crystals have occasionally been recorded. The total number of particles found is surprisingly large considering the character of the material, but small compared with the number of nuclei found by Aitken. For example, an average figure for London would be about 10,000 dust particles per c.c. The average number of condensation nuclei is about ten times this figure. If the ultra-microscope could be employed, as has been done with success in the examination of smokes, no doubt a considerable number of particles which are beyond the optical limits of the present method would be detected. But as, according to de Broglie, the ultra-microscope fails to show up the large ions, we can scarcely anticipate that any optical method will disclose the bulk of Aitken's nuclei.

Now it is not at all clear that the Aitken nuclei may not have effects in some respects more important than those of the visible nuclei. For example, the connexion between the concentration of nuclei and haze was pointed out by Aitken. Some part of the reduction in visibility in polluted air may be due to scattering by the large

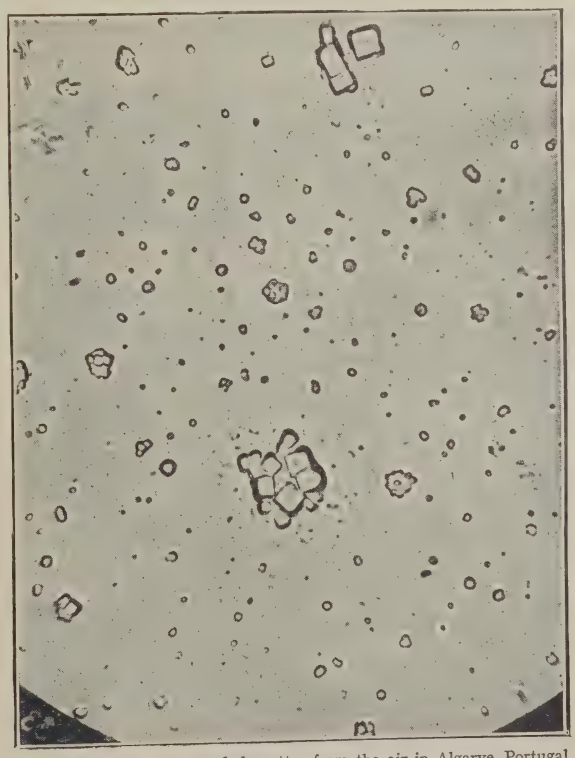

FIG. 3.—Record of suspended matter from the air in Algarve, Portugal, taken on a hot, sunny day. The particles consist mainly of crystals of common salt. Photograph. Magnification 1000 diameters. Reproduced, by permission of the Controller of H.M. Stationery Office, from the Ninth Report of the Committee for the Investigation of Atmospheric Pollution.

numbers of nuclei. Again, in the phenomena of atmospheric electricity dealt with recently in these

pages by Dr. Chree and others, the nuclei, owing to their large numbers, have possibly a greater effect than the visible particles.

The effect of impure air on visibility has been investigated by the Committee and two photometric methods of measuring the obstructive power of polluted air have been perfected. Approximate proportionality has been established between the light obstruction and the quantity of pollution present as measured by the filter and jet methods. But the Committee finds that "some factor other than the simple obstruction of area of the light source is responsible for the loss of light in passing through the air." It might elucidate this point and help to a fuller examination of the whole problem of contaminated air if observations of the total condensation nuclei were taken after the manner of Aitken. It would be unsafe to assume a proportionality between the visible dust and the nuclei. Many sources of large particles may yield few nuclei and certain rich sources of nuclei, Bunsen flames, for example, may be expected to give few large particles. In this connexion the writer noticed some months ago that during a three weeks' gas-strike in Dublin, the number of large ions was much below the normal. Irregular variations are so common that it may be difficult to decide if the reduction is a genuine effect unless a further opportunity for investigation—otherwise undesirable—should present itself. The Committee has already achieved such a high level of success in the development of methods of observation and in the perfecting of instruments that if it can be induced to undertake the observation of condensation nuclei, those of us who are interested in atmospheric nucleation may expect to see instruments developed of a far higher standard of efficiency than those available at present.

It should be stated that the automatic dust-recorder and the jet dust counter are now in use in many countries. They are available for purchase, and full instructions for their operation can be obtained. There is no doubt that they will prove of great value in dealing with a multitude of problems relating to impure air.

The chief evil of a polluted atmosphere is not the æsthetic horror of the smoke canopy, the grimy buildings and the stunted vegetation. It is not even the inspiration of dirty air—and we learn from this report that in the course of twenty-four hours of a heavy smoke fog, the dweller in London breathes in 500,000,000,000 particles of suspended matter. The real crime is the cutting off of sunlight. We have yet to learn in detail how the impure atmosphere of cities operates to abstract those elements in sunlight which appear to be necessary for health, and we have yet to test the possibility of minimising the evil. Meanwhile it is to be hoped that the Committee on Atmospheric Pollution may be enabled to extend and develop the fruitful work it has undertaken.

J. J. NOLAN.

The "Terrella."

THE name "Terrella" appears to have been first used towards the end of the sixteenth century to describe a sphere of loadstone used as a miniature replica of the earth for the study of terrestrial magnetism. Seventeenth century writers mention terrellas fairly frequently but there are not many descriptions of particular specimens, and although considerable numbers must have been in use during the seventeenth century, very few indeed appear to have survived. Rounded loadstones had been used from very early days. Peregrinus, for example, in the thirteenth century, mentions a method of making them and of finding the poles, but he does not give any particular scientific use to which they could be turned.

It was not until Gilbert of Colchester, in the prosecution of his studies in magnetism, etc., found that a miniature of the globe constructed of a suitable piece of magnetic ore would be of great assistance in his researches, that the rounded loadstone of earlier investigators was developed into a more or less scientific instrument. Dr. Gilbert, early in his great work "De Magnete" (1600), gives details for the manufacture of an instrument "Called by us a Terrella," this being described as a "physical Corpuscle imbued with many virtues by means of which many abstruse and neglected truths in philosophy burried in piteous darkness may more readily become known to men."

Many chapters of "De Magnete" are wholly devoted to details as to manufacture, graduation and the experimental use to be made of the finished article. Chapter XVII., Book II., giving details of methods of arming to "increase the virtue" of the instrument, is of special interest in connexion with the three specimens to be described. In order to show the opinion of his successors the following extract from Sir Kenelm Digby's (1644) "Two Treatises, on the Nature of Bodies: and, the Nature of the Man's Soule is looked into" will be of interest—

"But to come to some experimentall proofes and Obseruations on the loadstone by which it will appeare that these causes are well esteemed and applyed, we must be beholdin to that admirable searcher of the nature of the loadstone, Dr. Gilbert; by means of whom and of Dr. Haruey, our nation may claim euen in this latter age as deserued a crowne for solide Philosophicall learning as for many ages together it hath done formerly for acute and subtile Speculations in Diuinity. But before I fall to particulars, I thinke it worth warning my Reader, how this great man arriued to discover so much of Magneticall Philosophy; that he, likewise, if he be desirous to search into nature, may, by imitation, aduance his thoughts and knowledge that way. In short, then, all the knowledge he gott of this subject was by forming a little loadstone into the shape of the Earth. By which means he compasses a wonderful designe which was to make the whole globe of the earth maniable; for he found the properties of the whole earth in that little body; which he therefore called 'Terrella' or 'Little Earth'; and which he could manage and trye experiences vpon att his will. And, in like manner any man that hath an ayme to aduance much in naturall sciences, must endeavour to draw the matter he inquireth of, into some such modell, or some kinde of manageable methode; which he may turne and winde as he pleaseth. And then lett him be sure, if he hath a competent vnderstanding, that he will not misse of his marke."

The following references to definite instruments may be found in seventeenth-century records.

1. John Evelyn, July 1655, in his diary mentions a "pretty terrella with the circles and showing the magnetic deviations."

2. Pepys under October 2, 1662, states he "received a letter from Mr. Barlow with a Terrella."

FIG. 1.

3. A terrella, 4½ in. in diameter, was presented in 1662 by King Charles II. to the Royal Society.

4. In Grew's catalogue and description of the rarities belonging to the Royal Society, and preserved at Gresham College (London, 1681, p. 364), is mentioned a terrella contrived by Sir Christopher Wren with one half immersed in the centre of a plane horizontal table.

5. In Sir John Pettus's "Fleta Minor," London 1683, in the "Dictionary of Metallick Words" at the end, under the word "Loadstone" occurs the following paragraph:

"Another piece of curiosity I saw in the hands of Sir William Persal (since deceased also), viz. a Terrella or Loadstone, of little more than 6 in. diameter, turned into a Globular form, and all the imaginary lines of our Terrestrial Globe, exactly drawn upon it, viz. the Arctick and Antarctick circles, the two Tropics, the two Colures, the Zodiac and Meridian: and these lines, and the several countryes, artificially painted on it."

So far as can be ascertained, only three instruments which can be strictly included under the term "Terrella" can now be traced, and as all three are at present in the Admiralty Compass Department Museum at Ditton Park, a brief description of their characteristics and the little that is known of their history is possible.

1. *Compass Department Terrella.*—This is by far the most finished and efficient instrument of the three; in fact, it is the only one which might be termed a scientific instrument, and which carried out Gilbert's practice to the utmost. Its history prior to the early years of the nineteenth century is unknown, but then it hung as a curiosity in the shop window of the well-known compass makers, Messrs. Grant Preston, Barr Street, London, and is mentioned as being seen there in 1844. It came into the personal possession of Captain W. Mayes, R.N. (Superintendent of Compass Department), in 1887, and has remained in the Museum since that date.

General Description.—The instrument (Fig. 1) consists of three parts: (*a*) the terrella of highly magnetic ore 1·7 inch in diameter, (*b*) and (*c*) two brass hemispheres which when screwed together form the arming and casing. Great circles and parallels of latitude are engraved on both the sphere and its case, and a very special feature of the latter is the iron cap (⅓ inch in diameter) let into the north pole forming one piece with the projection inside; the efficiency of this arrangement in collecting the lines of force is obvious from the increased lift given below, and the results would probably be better if the pin and depression in the north pole of the terrella were not considerably worn and the fit therefore loose, and also if suitably designed weights were used. The small pin at the south pole appears to be simply intended to hold the sphere firmly in place. The terrella itself weighs 6⅜ oz., and unarmed lifts 1¾ oz.; with the case in place, however, this lift is increased to 9⅜ oz.

2. *Royal Society Terrella* (R.S. No. 80).—This is a roughly turned sphere of loadstone 4⅜ in. in diameter, and marked with a cross at each pole. No method of arming is provided. It weighs 7 lb. 2½ oz., and has a lift of 6 oz.

3. *Royal Society Terrella, 3 in.*—Sphere of loadstone (Fig. 2) slightly flattened at the south pole. Faint red markings show that meridians and equator have been roughly drawn. For "arming"—the sphere is loosely held between two iron cups joined by a silver bridge. It weighs 2 lb. 1½ oz., and lifts when armed, 3 oz.

The summary of all the available information past and present on particular instruments is remarkably meagre, and, when it is considered that many must have been in use during the seventeenth century, it is surprising that more specimens have not survived in museums and private collections; it is possible that the publication of this short article will result in bringing to light a few more of these interesting instruments.

Dr. Gilbert's work evidently aroused the interest of many of the great investigators of his time, and there appears to have arisen a demand for "armed" loadstones as scientific curiosities which fetched high

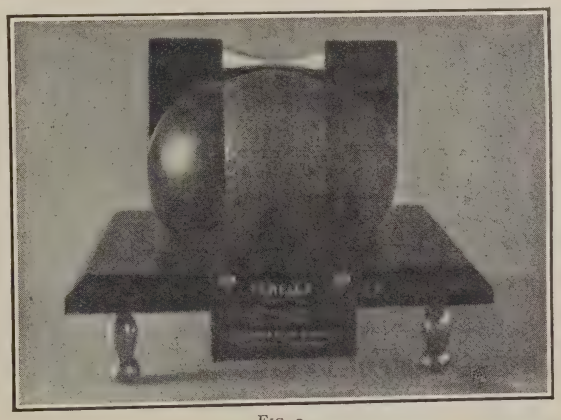

FIG. 2.

prices. Galileo especially brought their manufacture to a high pitch of perfection if the records of his achievements can be credited; his loadstones were not, however, terrellas, as is clear from the very interesting paper entitled "Galileo and Magnetism, a Study in Loadstones," by J. J. Fahie, published in the Journal of the Institution of Electrical Engineers, vol. 56, p. 246.

F. C.-O.

Obituary.

PROF. J. E. CREIGHTON.

NEWS reaches us from America of the death on October 8, after a long illness, of Prof. James Edwin Creighton, Sage professor of logic and metaphysic in Cornell University since 1895. The United States lose in him one of their most influential and deeply respected teachers. It is only a short time ago that Prof. Creighton's old pupils published a volume of essays in his honour. He was better known as a tutor and lecturer than as an author, though his "Introductory Logic" is widely used by students in Great Britain as well as in the United States. He was engaged on an important work, "The Rise of the Historical Method in Philosophy," when illness compelled him to set it aside. Outside his own university, he was widely known as editor of the *Philosophical Review*, one of the leading American journals devoted to philosophy, and representative of the idealist theories, also as American editor of "Kant-Studien."

Prof. Creighton was one of the founders of the American Philosophical Association, and its president in 1902 and 1903. He was a member of the permanent committee of the International Congresses of Philosophy and took great interest in the European meetings. It was one of his most ardent wishes to arrange an international meeting in the United States, and his death occurred just at the time when his Association is sending out its invitation to the VIth Congress to be held at an American University in 1926.

Prof. Creighton was born at Pictou, Nova Scotia, on April 8, 1861. He was educated at Dalhousie College, Halifax. The terrible explosion which occurred in that city during the War occasioned the loss of many friends and relatives, and he never completely recovered from the sorrow and shock which he suffered at that time. H. WILDON CARR.

WE learn with deep regret that Sir Archibald Geikie died on Monday, November 10, at the advanced age of eighty-eight years. The world of letters as well as that of science has thus lost a leader of the highest distinction, whose work has had a profound influence upon intellectual progress and the advancement of knowledge. A few months ago (NATURE, July 26) we published an appreciative survey of his activities in a review of his autobiography, and in our issue of January 5, 1893, his portrait appeared in the NATURE Series of Scientific Worthies, with a sketch of his career by Prof. A. de Lapparent. It is unnecessary to mention now his untiring activities in scientific fields or the many academic honours which came to him, but we are voicing the thought of the whole scientific world when we say that his death leaves a blank in the lives of all who are stimulated by human achievement.

WE regret to announce the following deaths:

M. L. E. Bertin, for many years director of naval construction in France, and an honorary member of the Institution of Naval Architects, who, in addition to his technical studies, contributed to our knowledge of the theory of waves, aged eighty-four.

Col. H. D. Love, from 1880 until 1907 principal of the Civil Engineering College at Madras, who was also a student of Anglo-Indian history, aged seventy-two.

Mr. R. W. M. Thomson, assistant lecturer in chemistry at King's College, University of London, on November 5, aged twenty-five.

Current Topics and Events.

THE following is a list of those recommended by the president and council for election to the council of the Royal Society at the anniversary meeting on December 1:—*President:* Sir Charles Sherrington; *Treasurer:* Sir David Prain; *Secretaries:* Mr. W. B. Hardy and Mr. J. H. Jeans; *Foreign Secretary:* Sir Richard Glazebrook; *Other Members of Council:* Sir Frederick Andrewes, Prof. J. H. Ashworth, Dr. F. W. Aston, Sir William Bragg, Prof. S. Chapman, Sir Dugald Clerk, Dr. H. H. Dale, Prof. F. G. Donnan, Prof. A. S. Eddington, Prof. E. S. Goodrich, Sir Thomas Holland, Prof. J. B. Leathes, Prof. T. R. Merton, Dr. G. C. Simpson, Prof. J. F. Thorpe, and Prof. F. E. Weiss. The Earl of Crawford and Balcarres and Sir Otto Beit have been elected fellows of the Royal Society under the Statute which permits of elections on the grounds of conspicuous services rendered to science.

H.M. THE KING has approved of the following awards this year by the president and council of the Royal Society:—A Royal Medal to Sir Dugald Clerk for his application of scientific principles to engineering problems, particularly to the development of the internal-combustion engine; and a Royal Medal to Dr. H. H. Dale, for his researches in pharmacology and physiology. The following awards have also been made by the president and council:—The Copley Medal to Sir E. Sharpey-Schafer, for his valuable work in physiology and histology; the Rumford Medal to Mr. C. V. Boys, for his invention of the gas calorimeter; the Davy Medal to Prof. A. G. Perkin, for his researches on the structure of natural colouring matters; and the Darwin Medal to Prof. T. H. Morgan, for his valuable work in zoology, especially his researches on heredity and cytology.

MRS. TYNDALL, widow of Prof. John Tyndall, has made a donation of 500*l.* to the Royal Society to be used at the discretion of the Tyndall Mining Bequest Committee, as a fund to meet out-of-pocket expenses incurred by the Tyndall Research Student in carrying out his investigations. This gift is additional to the sum of 1000*l.* entrusted to the Royal Society in 1910 for the purpose of encouraging and furthering research in all matters pertaining to mining, including such questions as ventilation, temperature, diseases incidental to miners, and so forth. The income of the former gift is utilised to promote research relating to mining, and much valuable work has been done in connexion with the physiological condition of miners and their safety in mines.

THE art of radio communication continues to make marvellous advances. Amateurs have now established communication with New Zealand. To Mr. Boyder, of Mill Hill School (2SZ), must be given the credit of being the first to establish two-way communication with that country. Before 1923, there was a ban on amateur radio in New Zealand, but after that date two kinds of licenses were issued. Those who have a first-class license can use 50 watts for transmission; that is the power taken by an ordinary electric lamp. Those who have second-class licenses are restricted to 5 watts. To obtain a license it is necessary to pass an examination in theory, in the Morse code, and in the regulations. The reception of the signals in Great Britain is erratic. The signal strength is weak at the start, increases gradually, and finally fades away. The period of audibility is between 6.15 A.M. and 7.30 A.M., G.M.T. One interesting fact is that the only New Zealand stations heard are two in the town of Dunedin and one about fifty miles away. The stations in the North Island have not yet been heard in Great Britain.

IN communicating with the Antipodes, the radio waves must travel in both directions round the earth. It is probable that they interfere with one another, producing nodes and loops, and it is possible that the wave-lengths of the two sets of incoming waves may not be exactly the same. It is curious that the two-way working with New Zealand has apparently not been intercepted by any of the numerous workers in America. In the *Radio Review* for Nov. 5, Mr. Orbell gives an interesting account of the phenomena he noticed in a voyage from New Zealand. For example, the United States amateur signals were constantly heard. They reached a maximum strength about halfway across the Pacific, then reached a minimum when rounding Cape Horn. Finally, near Las Palmas in the Atlantic, they regained their maximum strength. The continent of South America seemed to screen them very efficiently. The amateurs of Great Britain and New Zealand are to be congratulated on having made a notable step forward in our knowledge. We venture to predict that short wave-length transmission will play a notable part in long distance transmission in the future.

THE Tokyo correspondent of the *Times* has given in the issue for November 8 an interesting account of the scheme for rebuilding the city. The old narrow alleys, down which no fire-engine could pass, are to be abolished, practically every street is to be widened, and there will be several entirely new main thoroughfares. The total area of all the widened streets will be nearly 13 square miles, but this includes one very large market and numerous parks and open spaces. To obtain the land required for these improvements, every owner is compelled to yield up one-tenth of his present holding without compensation. Open spaces to act as refuges in case of fire are to be provided by building all the primary schools of the city within spacious playgrounds. It was proposed that there should be numerous small parks each with a pool in it to serve as an emergency water-supply, but this plan has been abandoned. Instead of this, some of the canals are to be widened and the water-mains are to be made, so far as possible, earthquake-proof. They are to be constructed on a new elastic principle and supported in conduits without coming in actual contact with the ground.

THE ground floor of the Main Hall of the new Science Museum at South Kensington is at last so far advanced that in a short time it will be thrown open to the public. The six fine old steam engines representing the work of Newcomen, Smeaton, Watt, and others, together with the historic locomotives Puffing Billy, Agenoria, Sans Pareil, and Rocket, were re-erected in the Main Hall some time ago, but now the smaller engines and models are being transferred from the older galleries. When this work is completed, for the first time in the history of the Science Museum the visitor will see the main engineering collections in a proper setting. The increase in floor space is all the more welcome inasmuch as for many years some of the finest collections in the Museum, such as the textile and mining exhibits, have had to be withdrawn from exhibition. As originally planned, the new building—which is but a third of the scheme proposed in 1911—should have been ready for occupation in 1915. The War, however, brought building operations to a standstill, and since 1918 other causes have hindered the progress of the work. With the opening of the New Hall we trust that the Office of Works will do something to improve the so-called temporary entrance as approached by the passage leading from Exhibition Road. Its present state is a standing reproach to those responsible for the upkeep of our national buildings.

ON November 5 the members of the Geological Society Club dined together as usual after the meeting of the Society. The occasion, however, was a special one, being the exact centenary anniversary of the first dinner of the Club in 1824, and a number of distinguished guests were invited to take part in the celebration of the event. Sir William Boyd-Dawkins, who was already a member of the Club fifty years ago when its jubilee was celebrated, proposed the toast of kindred clubs, which was responded to by Sir Charles Sherrington, president of the Royal Society. Sir Arthur Smith Woodward then proposed the guests, to which Sir Richard Gregory and Prof. Schaffer of Vienna responded. The latter remarked that the century of comradeship typified by the existence of the Club dinner appealed more to his imagination than anything else in the geological past. Sir William Bragg proposed the toast of the Club, and Dr. J. W. Evans, in replying, reminded those present of the great changes in geological science since the Club was founded. Then there were no Cambrian, Ordovician, Silurian, or Devonian periods, and the Tertiary had not been subdivided by Lyell, one of the founders of the Club, who survived to take part in its jubilee. There was no glacial period, prehistoric man, or evolution—no rock sections or petrological microscopes. Dr. Evans referred to the importance of the office of treasurer, and proposed the toast of past holders of that post, and more especially of the present treasurer, Mr. G. W. Lamplugh, who, in responding,

remarked his indebtedness to Prof. W. W. Watts, and on the curious coincidence that both at the jubilee and the centenary dinners the president was a John Evans. Letters expressive of good will and regret at their absence, were despatched to Sir Archibald Geikie, Mr. William Whitaker, and Mr. E. T. Newton, honorary members of the Club. They were signed by practically all those who were present at the dinner. An interesting list of the membership of the Club since the beginning was prepared by Mr. Lamplugh and presented to the members and guests.

In our issue of September 13 we dealt with the centenary of the Franklin Institute. We have now received a copy of the booklet published in connexion with the commemoration of that event. It contains a chronicle of some of the most important events in the history of the Institute, an interesting series of illustrations of Philadelphia old and new, some portraits, and also photographs of scientific apparatus, among which we notice Franklin's electrical machine, an air-pump once belonging to Priestley, and Saxton's early magneto-electric machine. The Institute has always encouraged exhibitions of inventions, and to the initiative of its members was due the inauguration of the famous Centennial Exposition of 1876 and the Electrical Exhibition of 1884, both of which had far-reaching results. "For the encouragement of invention and discovery no method is more efficacious," the authors of the booklet appropriately write, "than an exhibit of what has already been done. Two purposes are served. The exhibits stimulate interest and lead to efforts to improve upon what has been accomplished, and show those who are inclined to enter upon invention or discovery in any field what is the 'state of the art,' knowledge that saves many an hour otherwise wasted in going over ground already covered." Franklin's own work as a scientific investigator commenced about 1746, and seven years later he received the Copley Medal of the Royal Society. During his second stay in England he became the friend of Canton, Priestley, Wilson, Maskelyne, and Watson, and he had a share in placing his own lightning conductors on St. Paul's Cathedral. There are many memorials of him in Britain, in France, and in the United States, but none more worthy than the great Institute bearing his name, which was founded thirty-four years after his death.

In the *Empire Review* for November, Dr. R. P. Scott argues that the Bill to release China from further payment of instalments of the Boxer Indemnity, which has been before Parliament since May last, should be amended by defining the undertakings beneficial to both countries, to which the money is to be diverted under the provisions of the Bill, as "Educational or Cultural." Those who know China are agreed that the claims of medicine and surgery for support are valid and obvious, and that the term "cultural" should cover these chiefly, if not entirely. The Chinese national character, both in its strong as well as its weak points, indicates unmistakably the great need of assisting and supplementing the efforts made by the Chinese to reform their educational system. The co-operation of the Chinese themselves is essential, and efforts should be directed towards securing a system of education which, while thoroughly in accord with Western standards, should at the same time be national, unlike at least one of the attempts at reform from outside which has brought disillusion by denationalising the students. Existing institutions, whether Chinese or foreign, should be subsidised, and those which are outside the national system should be kept abreast of it in grade by a system of inspection and advice worked through a conjoint central and local system. It might then be possible to convince China of the value of institutions engaged in developing a Chinese stock which had assimilated Western culture without becoming denationalised. Granted an effective co-operation between British and Chinese workers, it should be possible at the end of twenty-three years, when the payments on account of the indemnity will cease, to judge the experiment on its merits. If it has been successful it should, by that time, be self-supporting.

Sir Alfred Ewing, president of the Royal Society of Edinburgh, in an address on November 3, remarked that in this, the centenary year of Lord Kelvin's birth, it was fitting that the Society should call to remembrance one who was for long its most distinguished fellow, who first became its president at the age of thirty-nine, and was repeatedly re-elected to that office, which he held for twenty-one years in all, and who used the Society as a medium for the publication of many of his most brilliant discoveries. It was to this Society, in 1849, that he gave the account of Carnot's theory which marks the beginning of his study of thermodynamics, and it was also in the Edinburgh Transactions that he published his epoch-making series of papers on the dynamic theory of heat. It was there too that he propounded the doctrine of the dissipation of energy in 1852, and in 1865 briefly refuted the doctrine of uniformity in geology. It was to the Royal Society of Edinburgh that he brought his long series of papers on vortex motion and vortex atoms and his work on the molecular constitution of matter, and his last paper of all, on the problem of a gaseous nebula, was published there posthumously in 1908.

Important and valuable as Kelvin's practical inventions were, continued Sir Alfred Ewing in the address referred to above, and the work in discovery which he continued to do to the end of his life, his very greatest contributions to science were made before he was thirty, when he was engaged in developing the science of energetics. Founding himself on the earlier work of Carnot, he gave to the world the conception of an absolute scale of temperature, and once he succeeded in reconciling the principles of Carnot with the later work of Joule, he pressed forward at an amazing pace, applying the new ideas to one group after another of physical phenomena, and showing that the first and second laws of thermodynamics together formed a master-key to unlock every door. After setting on a sound basis the theory of the pro-

ction of the motive power by the agency of heat, went on to give the principle of the reversible cycle any fruitful applications in other fields. In thermo-ectricity it led him to discover what is now known the Thomson effect. In the theory of electrolysis used it to infer the electromotive force of the lvanic cell from the known energy of the chemical tion. His next step was to discuss the mechanical lues, or as would be now said, the potential energy distributions of electricity and magnetism, and he owed how at every instant of the process of dis-arging a conductor the strength of the current ight be deduced by applying the equation of energy, id how it followed that the discharge would be scillatory, provided the resistance fell short of a rtain limit depending on the self-induction and the pacity. This investigation of transient currents as the first step towards wireless telegraphy, though was left to Clerk Maxwell to recognise, years after-ards, that Thomson's equation omitted one term, amely, the energy of electromagnetic waves, which, as a nsequence of the oscillation, are radiated into space.

MR. T. MARK HOVELL delivered a Chadwick Public ecture on November 10 on "The Rat Menace: its al significance and how it may be minimised." was stated that although rats are costing Great ritain alone 1,000,000*l.* per week, continuous war is ot waged against them. There is a Rats and Mice Destruction) Act, 1919, which authorises fines to the tent of 20*l.*, but it is not put in force. "Rat eeks" do a great amount of good, but there will be o decided diminution in the number of rats until ntinuous trapping is enforced. The presence of a few" rats is usually disregarded; it is not always alised that a pair and their descendants, at a low mputation, will produce in eleven months 1130, and thirteen months 3050 individuals. Farmers usually llow their stacks to be rat-infested, but in six months 132 rats will eat and waste wheat to the equivalent f 2329 quartern loaves, 306 bushels of sharps and 23 bushels of bran. Mr. Mark Hovell also stated hat rats convey trichinosis (measly meat), foot-nd-mouth disease, infectious jaundice, mange, ring-orm, distemper, rat-bite fever, and last, but not ast, plague, which during last March in the Punjab lone caused 25,000 deaths. Plague is conveyed to uman beings by the rat-flea, and, contrary to general elief, the flea of the brown rat transmits plague as eadily as the flea of the black rat. Careful supervision t the ports prevents serious outbreaks of plague in Great Britain. For destroying rats, it appears that irus has no advantage over the recognised poisons, and ts use is strongly deprecated because it disseminates irulent microbes which the medical profession is rying to eradicate. The next Chadwick Public Lecture will be delivered by Prof. J. B. Cohen on Wednesday, November 19, at 8 P.M. in the Gallery of he Royal Institute of British Architects, 9 Conduit Street, on "Smoke: Cause, Nature, Effects and Methods of Prevention." Further particulars of Chadwick Public Lectures may be obtained of the Secretary, Mrs. Aubrey Richardson, at the offices of he Trust, 13 Gt. George Street, Westminster.

SIR OLIVER LODGE has been elected an honorary member of the Institution of Electrical Engineers.

THE Huxley memorial lecture of the Royal Anthropological Institute for the present year will be delivered at 8.30 on Tuesday, November 25, at the Royal Society, by Prof. Réné Verneau, who will take as his subject "La Race de Néanderthal et la race de Grimaldi: leur rôle dans l'humanité."

NOTICE is given that applications for the Government grant for scientific investigations must be sent to reach the Royal Society, Burlington House, London, W.1, not later than January 1, on a form obtainable from the clerk to the Government Grant Committee, c/o the Royal Society.

PROF. E. P. CATHCART, professor of physiological chemistry in the University of Glasgow, has been appointed to the vacancy in the membership of the Medical Research Council caused by the retirement of Prof. D. Noël Paton.

WE learn that Senatore Marconi has returned to London after an absence of about three months, during which time he has been further developing his new beam system. He is now able to state that this system will be effective for efficient telegraph service over any distance by day as well as by night.

THE first of the Christmas Lectures at the Royal Institution, "Concerning the Habits of Insects," to be delivered by Mr. F. Balfour Browne, will be given on Dec. 27, and will be concerned with insect collecting and what it leads to. Succeeding lectures will deal with the habits of bees and wasps (Dec. 30), habits of caterpillars (Jan. 1), habits of the dragon-fly (Jan. 3), habits of the water-beetle (Jan. 6), and the habits of insects and the work of man (Jan. 8).

PROF. WILLARD C. THOMPSON, head of the Poultry Division of the New Jersey State Agricultural Experiment Station, U.S.A., has been appointed Director of the National Poultry Institute (Harper Adams College Section), and has agreed to act in that capacity for two years. Prof. Thompson has done work that has greatly benefited the industry in America, and brings to his new task considerable experience in teaching and research, and a wide knowledge of the problems that confront practical producers.

A TEMPORARY inspector is required by the Ministry of Agriculture and Fisheries mainly for work in connexion with the Young Farmers' Club Movement. Candidates must have a general knowledge of agriculture, and the possession of a University degree and acquaintance with county organisation and educational work is desirable. Application forms (returnable by November 22 at latest) can be obtained from the Secretary to the Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1.

APPLICATIONS are invited for the post of an experimental physicist at the Building Research Station of the Department of Scientific and Industrial Research. Candidates must be honours graduates in physics with research experience, and have a sound general

knowledge of physics, with, preferably, specialised acquaintance with heat and properties of matter. Applications, on a form supplied upon request, should reach the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1, by, at latest, November 24.

THE Home Secretary has appointed a committee to consider and report whether any, and if so what, modifications of the existing statutory regulations governing the use of artificial humidity in cotton cloth factories are desirable and practicable. The members of the committee are: Mr. J. Jackson (chairman), Mr. L. Bates, Mr. J. Cross, Dr. A. W. Crossley, Mr. G. Green, Prof. Leonard E. Hill, Mr. J. Hindle, Mr. H. Roberts, Mr. F. Scarisbrick, Mr. C. Speak, Mr. John Stuttard, and Mr. D. R. Wilson. The secretary of the committee is Mr. T. P. Threlkeld, of 72 Bridge Street, Manchester, to whom any correspondence should be addressed.

ON October 18, Sir Archibald Garrod delivered the Harveian Oration before the Royal College of Physicians. His subject was "The Debt of Science to Medicine." Like all Sir Archibald's work, his Oration was distinguished by great accuracy and wide learning. He traversed the field from Hippocrates to Sir Edward Sharpey-Schafer and strove to show that science in the pure sense has been greatly enriched by medical men in different ages. Sir Archibald thinks that the marvel is that medical men have contributed so much, not that they have failed to contribute more, considering that clinical medicine is an art as well as a science and that the successful practice of medicine calls for qualities which are often unconnected with science. He pleaded for greater unity between science and practice for those who have the beneficent aims of medicine at heart. The Oration, which will be found in the *British Medical Journal* for October 25, is well worth a careful perusal.

WE have received from the British Museum (Natural History) ten recently issued sets of postcards of butterflies and moths. They are all admirable reproductions by the three-colour process, made from actual specimens, and are among the most perfect examples of that art which have come to our notice. The series of British Butterflies (Nos. 2 to 7), together with their accompanying letterpress, form an excellent guide to those insects which will enable any one readily to identify the various species found in the British Isles. The series No. 2 of British Moths illustrates some of the less common and other species, including the recently detected *Anaitis efformata*. Series Nos. 4 to 6 of Exotic Moths include a number of striking or otherwise remarkable forms. The cards are sold in sets of five (with separate explanatory letterpress) at the low price of 1*s*. per set, and are to be specially commended to all interested in nature study and insect life in particular.

APPLICATIONS for grants from the Chemical Society Research Fund must be received, upon a prescribed form, by the Assistant Secretary of the Society not later than December 1. The Selection Committee of the Harrison Memorial Prize will meet shortly to consider the award of the prize, which is of the value of about 150*l*. The award will be made to the chemist of either sex, natural British born and not more than thirty years of age, who, in the opinion of the committee, has during the previous five years conducted the most meritorious and promising original investigations in any branch of pure or applied chemistry and published the results. Applications must reach the president of the Chemical Society, Burlington House, Piccadilly, W.1, not later than December 1.

Our Astronomical Column.

CALENDAR REFORM.—Mr. G. Marvin, of the U.S. Weather Bureau, read a paper on this subject at the Madrid meeting of the Geodetical and Geophysical Union. He dwelt chiefly on the need of more uniform months for the purpose of meteorological records, and the desirability of keeping the date of the equinox as nearly as possible the same. He recommends the system of 13 months of 4 weeks each, and one day each year (two in leap year) outside the month and week.

Taking account of the shortening of the year due to solar acceleration (Mr. Marvin does not give any details of the amount that he adopts or its source), he notes that the best rule would be to drop 4 leap years in 500 years, instead of 3 in 400 as at present, or 7 in 900 as in the new rule of the Greek Church. He suggests making 1928 a common year to bring the equinox back to March 21, and then to make the centennial years leap years only when divisible by 500: thus 2000, 2500, 3000, etc., would be leap years, the other years ending in 00 common years.

THE BAADE PLANET.—The arc of observation for this planet is now sufficient to deduce approximate elliptical elements, which result as follows:

T	1894 Sept. 27·7609 G.M.T.
ω	130° 0′ 24″
Ω	217 4 35
i	25 27 32
ϕ	30 0 9
Period	3^{y}·8047
log q	0·0858.

The perihelion distance is somewhat greater than that of Eros, and the eccentricity much greater, the aphelion distance being 3·66. The orbit is of the same type as those of Albert and Alinda; the brightness is, however, much greater.

The planet is getting fainter, but is still an easy object for ordinary telescopes. It will be too faint for easy detection at aphelion oppositions, so it is important to observe it over a long arc to secure its recovery in 1928.

EPHEMERIS FOR GREENWICH MIDNIGHT.

	R.A.	Decl.	log r.	log Δ.
Nov. 16	22^{h} 57^{m} 23^{s}	1° 36′ N.	0·1247	9·7783
20	23 13 39	0 4 N.	0·1304	9·8016
24	23 29 10	1 15 S.	0·1362	9·8253
28	23 43 51	2 18 S.	0·1423	9·8501
Dec. 2	23 57 53	3 11 S.	0·1485	9·8745

Research Items.

MOUND EXPLORATION IN CALIFORNIA.—Observations made in the course of levelling two mounds for city improvements at Richmond, Ca., have afforded several additions of interest to the accumulating evidence relating to the early culture and history of man on the American continent, which is being obtained from archæological investigations in California. The two mounds in question, the Stege mounds, are situated on the Oakland-Richmond beach immediately opposite the outlet of San Francisco Bay in an area about 6 miles long and 3½ miles wide, which includes some of the largest shell mounds of the region, and where the shallow waters provided a favourable ground for fishing in primitive times. The objects found in the course of the demolition of the mounds are described by Mr. Ll. L. Loud in vol. 17, No. 6, of the University of California Publications in American Archæology and Ethnology. They included human remains, some showing signs of incineration, implements of bone and stone, net sinkers, pestles and mortars, the former of several types, hammer stones, and charmstones. The larger of the two mounds afforded abundant evidence that it had been the site of manufacture of objects made of greenstone schist, for which no doubt it had acquired a reputation, and had become a manufacturing and distributing centre according to what appears to have been Indian custom. Of greater interest, however, is the distinction in culture to be drawn between the two mounds, which distinctly points to somewhat different modes of subsistence and may indicate a difference in date.

EARLY DEVELOPMENT OF THE HUMAN EMBRYO.—Prof. T. H. Bryce's "Observations" on this subject have just been published as a separate memoir in the Transactions of the Royal Society of Edinburgh (vol. 53, Part 3, 1924). They should be studied in conjunction with Prof. Teacher's paper on the implantation of the ovum, which was recently noticed in NATURE (Sept. 6, p. 367). Indeed the two memoirs deal largely with the same material, but from different points of view, and so supplement one another. Prof. Bryce, however, besides describing the two Teacher-Bryce ova, includes an account of an entirely new early embryo obtained by Dr. Donald M'Intyre from a uterus removed surgically by sub-total hysterectomy. The memoir contains a number of important observations, some of which are confirmatory of former discoveries and some of which are new. In dealing with the primitive extra-embryonic mesoderm, it is shown that this is primarily an angioblastic tissue. All round the young chorion the formation of vascular channels has begun in it (in the second Teacher-Bryce ovum) before there are any vessels in the yolk-sac and apart from the formation of blood corpuscles. The embryo is afterwards linked up with this system of vascular channels through vessels developed in the allantoic stalk. The author also describes the primary connexions of the yolk-sac and chorion, and points out that the observations support the view that the small size of the yolk-sac in the primates is a secondary condition, its recession being very precocious, but agreeing essentially with what occurs at a later stage in many of the lower mammals. The yolk-sac duct, which is described, is regarded as a vestigial structure reminiscent of a phylogenetic phase when the organ was of larger size. The memoir contains also new and interesting facts relating to the amnion and its duct, the primitive streak and the archenteric canal. It is illustrated by nine plates containing nearly fifty well-executed figures.

OBSERVATIONS ON COLEOPTERA.—*The Entomologist's Monthly Magazine* for October 1924 contains several short articles and notes of interest to coleopterists. Mr. Horace Donisthorpe discusses the European species of the genus Euryusa, the species of which are mymecophilous and live in trees inhabited by ants of the genus Acanthomyops. The exact relations between these beetles and their hosts is still in need of elucidation. Mr. Donisthorpe admits five species and provides a key for their identification. Messrs. J. W. Allen and G. W. Nicholson add a new beetle, *Tachys micros* Fisch., to the British fauna on the strength of taking a considerable number of examples near the coast in Dorsetshire. They also record the occurrence of *Chlaenius schranki* Dufts. in the same situation: this insect was thought to have become extinct since its disappearance from its habitat in the Isle of Wight many years ago. Notes on two beetles recently added to the British list are also included in the same issue of the journal. Mr. B. S. Williams records *Anthicus bifasciatus* from Wicken: it may be added that the insect was first recognised as British in 1914 from Chatteris. Messrs. Allen and Nicholson record *Sitones gemellatus* from Branscombe, S. Devon, where it occurred in some numbers under shoots of *Ononis arvensis*. This insect has only recently been recorded as British, the first examples being found at Sidmouth.

HETEROTHALLISM IN PHYTOPHTHORA.—This problem is carried one step further (see NATURE, Vol. 111, p. 61, 1923) by a paper by C. H. Gadd in the Annals of the Royal Botanic Gardens, Peradeniya, vol. ix. Part I., which gives the results of a comparative study of strains of Phytophthora isolated from cacao, papaw, Hevea, Dendrobium, Odontadenia, and breadfruit in Ceylon. All these strains are regarded by the author as biological varieties of *P. Faberi*. None of them formed oospores so long as grown in pure culture, but they could be divided into two groups, + strains on cacao and papaw and − strains on the other hosts, and oospores were formed when any representatives of these two groups were mingled in cultures. Gadd also confirms the curious earlier result reported by Ashby, that oospores are formed when a pure culture of a strain of *P. Faberi* is mixed with a pure strain of *P. parasitica*. These oospores are of the size characteristic of *P. Faberi* and not of the other species.

THREAD BLIGHTS.—Under this title Mr. T. Petch, botanist and mycologist to the Department of Agriculture, Ceylon, describes (in the Annals of the Royal Botanic Gardens, Peradeniya, vol. ix. Part I.) a number of fungi which have the habit of forming well-defined, narrow strands of mycelium like coarse white threads ramifying over the branches and leaves of plants to a considerable height above the ground. These fungi are frequently seen in the tropics, attention having naturally been attracted to them when they are found on economic plants, as most of them seem to be parasitic, though usually doing little damage except to leaves and young stems. In two or three examples of these thread blights the hyphæ belong to a Corticium. In this case, the hyphæ usually remain thin-walled, and the threads composed of them are more transparent and less conspicuous; but in the majority of the specimens examined by Mr. Petch, in which the hyphæ are derived apparently from gill fungi, apparently species of Marasmius, though adult fructifications have only been described for two species, the bulk of the hyphæ in the threads of the superficial strands are thick-

walled or even solid, so that the threads are white and solid-looking and can withstand desiccation.

BREEDING EXPERIMENTS WITH ANTIRRHINUM.—Prof. Erwin Baur has now published a very full account of his studies of the different races of *Antirrhinum majus*, which he has had under investigation since 1904 ("Untersuchungen über das Wesen, die Entstehung und die Vererbung von Rassenunterschieden bei Antirrhinum majus." Von Erwin Baur. Bibliotheca Genetica, Band 4. Pp. iii + 170 + 8 Tafeln. Leipzig: Gebrüder Borntraeger, 1924. 39*s*. 6*d*.). The large number of forms of this species available in cultivation and the self-fertility of these garden forms have enabled the author to pay especial attention to the origin of mutations in progeny which had remained fixed in type for several generations of selfed parents. Many cases of such mutations are described at length, and Prof. Baur concludes that many of the distinct forms of Antirrhinum occurring in Nature are to be regarded as forms in which a number of different single-factor mutations occurring at different times have been accumulated, environment having then provided the opportunity for the isolation of such as local races. On the other hand, Baur points out that the forms selected in horticulture, on the contrary, usually show a single rather striking mutation that has appealed to the grower, and has been selected and maintained by the efforts of the breeder to keep it genetically pure.

FIXATION OF ATMOSPHERIC NITROGEN BY GREEN PLANTS.—This much-discussed problem comes to the fore again with the publication by Messrs. C. B. Lipman and J. K. Taylor of a full report of their Californian experiments, in the Journal of the Franklin Institute (October 1924, pp. 475-506). It will be recalled that, following in recent years close upon the paper by the late Prof. Benjamin Moore and his colleagues (Proc. Roy. Soc. 91B., 1920), in which nitrogen fixation by Algæ was claimed, but the significance of associated bacteria ignored, Wann published (*Amer. Jour. Botany*, 8, 1921) a series of chemical data which seemed to establish the same fact. Recently, however, the Rothamsted workers Mrs. Roach (Dr. Muriel Bristol) and H. J. Page, working with pure cultures of Algæ, have shown that Wann's claims are invalidated on questions of experimental method, whilst their own careful experiments give negative results. Messrs. Lipman and Taylor have worked with water cultures, especially of wheat and barley, and whilst it will be conceded that their chemical data leave no doubt that plants grown with no other nitrogen supply or with known additional amounts of nitrogen have gained further nitrogen when all other sources except gaseous atmospheric nitrogen seem to be excluded, yet at the same time critics will still argue that the inability to keep the culture solution sterile opens the door to alternative explanations. The writers, however, argue their case very cogently for rejecting the assumption that the gaseous nitrogen is assimilated and handed on to the green plant by bacteria.

PERMIAN INSECTS.—Hitherto few insects have been found in deposits of Permian age, but Sellards and Dunbar (*Amer. Journ. Sci.* vii., 1924, p. 171) have now discovered some thousands of specimens, many in a remarkably perfect state of preservation, in the Lower Permian (Artinskian) of Elmo, Kansas. They include may-flies, cockroaches, dragon flies, etc. This discovery is likely to be of great importance in phylogeny, since during Permian times the later orders of insects seem to have developed out of the more ancient Palæodictyoptera. The collection is being worked out by Dr. R. J. Tillyard. Up to the present he has described a new genus, Dunbaria, which is closely allied to forms found in the Upper Coal Measures of Commentry and is the first example of the Palæodictyoptera to be recorded from the Permian. Protohymen is the type of a new order, the Protohymenoptera, which is ancestral to the Hymenoptera, known first in the Upper Jurassic (*Amer. Journ. Sci.* viii., 1924, p. 111). The insects are found in a marly limestone and are associated with abundant land-plants and with the merostomes Palæolimulus and Eurypterus. The deposits underlying the insect bed contain thick layers of rock salt and other evidence of arid conditions, but the climate became ameliorated during the formation of the insect bed, which seems to have been the marly deposit of a freshwater lake.

LANDSLIPS IN ITALY.—The second number of the new journal *Matériaux pour l'étude des calamités* contains an interesting article by R. Almagia on landslips in Italy. They occur throughout the country, but especially in the sub-Apennine districts, Calabria, etc. The geological formations in which they are most prevalent are the clay strata of the tertiary period. They are most frequent during, or immediately after, periods of exceptionally heavy rainfall, the effect of which may be increased in spring by the melting of the snow, though some landslips may also be due to earthquakes and to deforestation. Some idea of the seriousness of landslips as a calamity may be gathered from the fact that more than three hundred villages in Italy are threatened. The Government has already voted funds for the protection of nearly half of these villages, but for many it is recognised that no adequate protection can be given, and that the only alternative is the removal of the inhabitants. This transfer seems inevitable in as many as seventy-seven villages in Calabria.

NATURE OF ISOSTATIC COMPENSATION.—A paper of interest to students of isostasy has recently been issued by the United States Coast and Geodetic Survey (Isostatic Investigations and Data for Gravity Stations in the United States established since 1915, by William Bowie, Spec. Pub. 99, 1924). Gravity determinations have been made at 94 new stations in addition to the 219 already completed at the beginning of 1916 (Spec. Pub. 40). In the light of all the results now accumulated, Bowie presents his matured views on the nature of isostatic compensation, the processes involved and the geological problems associated with them. He points out that the depth of compensation is not necessarily the same everywhere, but that for the United States the best average value is 96 km. The conclusion recently reached by Nansen in his book "The Strandflat and Isostasy," that movements restoring and maintaining equilibrium can take place within areas only a few hundred kilometres wide, is accepted, and a mechanism suggested. Briefly, the depression of geosynclines in which long-continued sedimentation takes place is ascribed to contraction and consequent increase of density of the block beneath the sinking area. Presumably diagenesis and pressure metamorphism, tending to the production of minerals of small specific volume, is the underlying physical cause. At a later stage, however, rising temperatures gradually reverse the volume changes, and the area begins to be uplifted owing to the expansion of the material of the underlying column. Few geologists are likely to agree with Bowie in his further deduction that mountains have been produced almost wholly by vertical uplift, and not by regional horizontal thrusts. The latter are said by Bowie to be inconceivable from an engineering point of view. Field evidence is nevertheless conclusively in favour of horizontal thrusts;

id for the geologist the two types of movement—ertical uplift and lateral thrusting—are by no vals. Both are required to explain the facts, and oth are probably due to temperature changes in the epths, expansion providing the local uplift, and ne concomitant weakening and fusion of the crust calising the forces of lateral compression set up by he general contraction of the earth.

CLIMATOLOGY OF THE INDIAN OCEAN.—An interesting series of charts of the Indian Ocean showing atmospheric pressure, winds, and currents has been compiled by Dr. P. H. Gallé and published by the Royal Dutch Meteorological Institute (*Mededeelingen en verhandelingen*, 29 *a*). The data have been obtained from the log-books and meteorological registers of the Dutch Navy and Dutch merchant vessels. The author has entered the mean values for January and July in one degree squares. In view of the number of observations, the results in most cases are fairly satisfactory, but Dr. Gallé admits that more accurate mean values could be obtained by further data, and one of his objects in publishing the charts is to invite wider co-operation. Observations are very scanty in some areas, particularly about lat. 30° S., between long. 60° and 90° E., and in winter about lat. 50° S. A comparison of mean values for pressure at land stations around the Indian Ocean, as given by Hann, Lockyer, Braak, and others, with the oceanic pressures, shows a fair agreement, but in places there are striking differences. These the author thinks are due in cases to prevailing local onshore winds and in other cases to a failure to apply accurate corrections for altitude on shore stations. In some of the coast regions two values are given where the divergence was found to be considerable. In regard to winds, these observations show that in the west wind belt of the "forties," the strength and stability of the air currents is not so marked as generally supposed. Further papers in this series are promised.

THE INVERSE STARK EFFECT.—Dr. R. Ladenburg, in the *Zeitschrift für Physik* of September 20, describes the behaviour of the D absorption lines in a strong electrical field. A new form of quartz sodium lamp enables the D lines to be produced with great intensity, and with a breadth of only 0·1 Å, without reversal, so that, using a large Lummer Gehrcke plate, broad interference maxima are obtained. The light from the lamp is passed through an absorption bulb, between two parallel metal surfaces a short distance apart, across which an electric field so high as 160,000 volts per cm. can be produced. The bulb is evacuated in an electric furnace, and pure sodium vapour is introduced. The D_1 and D_2 absorption lines then appear on the continuous background of the interference maxima, and when the light passes perpendicular to the lines of force, the absorption lines are shifted by the field towards the red. The shift amounts to 0·025 Å at 160,000 volts per cm., and is proportional to the square of the field intensity. The phenomena form a typical example of the purely unsymmetrical quadratic effect, which is to be expected according to Bohr's theory with lines unlike those of hydrogen, when the external electric field is small compared with that due to the electrons of the atomic kernel.

SPECTROSCOPY AND ATOMIC STRUCTURE.—The progress made during the past three or four years in the endeavour to discover a structure for the atom of each element which would, on the quantum theory, give a spectrum identical with that found experimentally, has been so rapid that none but specialists have been able to follow it in detail. An article of forty pages in the September and October issues of the Journal of the Franklin Institute by Dr. Paul D. Foote, of the Bureau of Standards, giving an account of the atomic models which have been suggested, will be welcomed by many who have not the opportunity to consult the original memoirs. He deals in turn with the "hydrogenic" atoms, the atoms with several electrons, the assignment of quantum numbers, *i.e.* integers, the necessity for the introduction of "effective" quantum numbers not integral, the orbital and precessional frequencies, and the representation of the orbits of luminous and X-ray frequencies. Figures of the orbits conceived by Bohr for helium, lithium, neon, sodium, argon, copper, krypton, xenon, and radium are reproduced with the warning that they are based on questionable assumptions.

VISCOSITY OF GLASS.—In a recent note on the viscosity of glass (*Comptes rendus*, Paris Academy of Sciences, 1924, p. 517) M. Henry Le Chatelier has shown that the law of the phenomenon can be represented as a function of the temperature by the very simple formula $\log(\log \eta) = -Mt + P$, where η is the viscosity, t the temperature, and M and P constants for a particular glass. Fifteen days later, S. English published in the Journal of the Society of Glass Technology (1924, p. 205) an extensive paper giving numerous viscosity data for different kinds of glass for temperatures ranging from 500° to 1500° C. Applying the formula given above to these data, M. Le Chatelier (*Comptes rendus*, 1924, p. 718) shows that for each glass the results can be expressed by two straight lines meeting at an obtuse angle, the temperature of inflexion varying from 750° C. to 950° C. according to the nature of the glass. To explain these facts, it is assumed that there are two allotropic varieties of each glass possessing different laws for the viscosity variation. This hypothesis was put forward by M. Le Chatelier in his first paper as affording the best explanation of his experiments: it explains equally well the results given by English, which are more numerous and cover a wider range of temperatures.

THALLOUS THALLIC HALIDES.—In the Proceedings of the Cambridge Philosophical Society, vol. xxii, part 3, Mr. A. J. Berry describes some experiments on the sesqui-halides of thallium, $TlX_3,3TlX$, no definite proof of the individuality of which had formerly been given. Solutions of thallous and thallic chlorides containing the two halides in varying proportions were prepared and the composition of the crystals deposited from such solutions determined. It was found that while the composition of the liquid phase could be varied over a wide range, the composition of the solid phase deposited was practically constant. The solution of thallic chloride was prepared by dissolving thallic oxide, obtained from the recrystallised sulphate by oxidation with alkaline potassium ferricyanide, in normal hydrochloric acid. After prolonged heating, the excess of thallic oxide was removed by filtration, and the ratio of thallium to chlorine found to be 1 : 3·1. The compound $TlBr_3,TlBr$ was easily obtained, but $TlBr_3,3TlBr$ was difficult to prepare in a state of purity. $TlBr_3$, $3TlCl$ was prepared. No evidence of the existence of complex ions was found. The substances, mostly red, become very much lighter in colour on cooling in liquid air, and the phenomenon is very strongly marked.

ERRATUM.—In the paragraph referring to "A Biochemical Basis to Disease Resistance" in NATURE of November 1, p. 657, line 11, the sentence "immune forms are comparatively high in total nitrogen and total ash" should read "susceptible forms are comparatively high in total nitrogen and total ash."

Effect of Artificial Light on the Growth of Plants.

THE effect of light on plant life has been the subject of many scientific investigations. So long ago as 1880 Siemens showed that continuous exposure to arc lamps promoted luxuriance of foliage, greater intensity of colouring, and more rapid ripening of fruit. It is common knowledge that plants grown in partial shade are apt to be weakly, and that the flowers, if produced, have in general a fainter shade of colour. Other examples were mentioned by Schübeler in a communication to the British Association in 1881. The extraordinary rapid growth of vegetation in the Arctic regions during the period of uninterrupted daylight has been the subject of comment; likewise the rapid ripening of corn in regions of Norway and Sweden where the summer does not exceed two months, but where, during this period, the sun scarcely sets.

It therefore seems somewhat surprising that greater use has not hitherto been made of the use of artificial light in horticulture. There have, in the past, been intermittent experiments, but results have been somewhat discouraging, and the probable reason is not far to seek. It is only within recent years, when convenient methods of measuring light have become general, that the great disparity between the intensity of full daylight and artificial light has come to be properly understood. The illumination derived from direct sunlight in summer may attain 10,000 foot-candles, and even with a cloudy sky a value of several thousand foot-candles is quite usual. On the other hand, the average illumination in an artificially lighted building is frequently less than three foot-candles; a general illumination of ten foot-candles would be considered exceptionally bright. The marvellous power of adaptation of the eye enables it to utilise these extreme variations in illumination. But it can be readily appreciated that unless an artificial illumination of at least several hundreds of foot-candles can be provided, the effect on the growth of plants would not be marked.

Until a few years ago there were few sources of light that could be conveniently applied to produce such high intensities, and the cost was commercially prohibitive. But the advent of such sources as the electric gas-filled lamp, furnishing 1000 c.p. or more, and capable of being equipped with suitable reflectors to concentrate the available light within a narrow area, has improved the position considerably. For some time experiments have been in progress at various agricultural experimental stations in the United States, and some results of these researches were recently summarised in a series of papers read before the American Illuminating Engineering Society.

The light was provided by electric gas-filled lamps, and values of illumination varying from 300 to 1500 foot-candles were furnished. The exposure to artificial light was supplementary to the natural lighting and had a material effect in hastening the growth of seedlings. Provided that proper attention was paid to the conditions which are ordinarily observed in horticulture—for example, the provision of sufficient space for normal development of each plant, proper soil, maintenance of correct conditions in regard to moisture and temperature, etc.—the more rapid growth was not attended by weakness. On the contrary, the plants were exceptionally robust and, it is stated, less liable to the ravages of fungus and other diseases.

The most striking effect of the increased light, however, was in hastening the time of blooming. On the average, flowering plants came into bloom eight days earlier than when no artificial light was used. Mr. R. B. Harvey, recording tests made at the Minnesota Experiment Station, mentions that the effect of continuous illumination is to cause the accumulation of large quantities of starch in the plants; thus, buckwheat was so full of starch that the grains may be pulverised in the hand. Apparently the desirable illumination varies for different plants. Strawberries, for example, did not bloom at 500 foot-candles, but set fruits at intensities of more than 1500 foot-candles. Prof. H. Findlay, of Columbia University, reports similar experience. The development of bloom in most plants was accelerated by about eight days; marguerites came into bloom eighteen days after the lights were turned on, when similar plants, grown only under sunlight, were scarcely showing bud.

Another question, apart from effect of intensity, is the influence of *colour* of light. It would seem that light from the electric gas-filled lamp may, as regards its effect on vegetation, be regarded as broadly similar to daylight, and probably the same would apply to other illuminants giving continuous spectra and approximately white light. Early experiments on the effect of colour seem to have been somewhat inconclusive, owing to uncertainty regarding the relative intensity. Thus, the effect of inserting a pane of blue glass is naturally to diminish the brightness of the light very considerably, besides restricting the rays to the blue end of the spectrum. Some remarkable results have, however, been recorded by M. Camille Flammarion,[1] who attempted the culture of the sensitive mimosa plant under light of different colours. Plants placed in blue light scarcely gained in growth at all, and also appeared to be in a comatose state, showing none of the sensibility to touch characteristic of the mimosa. Plants grown under red light were, on the other hand, four times as big as those grown under white light, developed well-marked flower balls, and were in an extremely sensitive state. From these and other experiments the conclusion has been drawn that red, orange, and yellow rays, by building up complex organic chains of molecules, stimulate plant life, whereas blue rays have an arresting effect. Ultra-violet rays, when present in excess, undoubtedly may have a prejudicial effect, causing shrivelling of the leaves and ultimately the death of the plant. In judicious proportions, they may, however, prove beneficial, as is believed to be the case in regard to the human body. Instances of their use to destroy greenfly and similar pests have been recorded.

Here, therefore, is a good field for experiment. We have still much to learn regarding the effects of sustained exposure to strong white light, whilst the effect of light of specific wave-lengths has been only very imperfectly studied. It would be very desirable for corroborative investigations, similar to those conducted at research stations in the United States, to be undertaken by leading horticulturists in Great Britain. At present it is not anticipated that artificial light could be economically applied to the production of common foodstuffs on a large scale; but it is believed that its use may prove extremely valuable for the purpose of raising scarce fruits and flowers out of season. It is even possible—though apparently this requires confirmation—that the work might be conducted entirely by artificial light in a well-heated and ventilated cellar in cases where no garden is available, thus bringing this field of investigation within the scope of the town-dweller in congested districts.

[1] Bulletin de la Société Astronomique de France, Aug. 1897.

The Origin of Limestones.

LIMESTONE takes high rank among those common things the proper understanding of which leads one into a wide circle of the sciences. In a British Association lecture at Norwich in 1868 "On a piece of chalk," Huxley declared that any one who acquired a knowledge of the history of a piece of chalk had a far truer conception of the universe, and man's relation to it, than one well-read in human records and ignorant of those of nature. This statement by Huxley concerning a piece of chalk applies with added force to the natural history and uses of limestones as a whole; for it should be emphasised that the use of limestone contributes very largely, and in ways too numerous to mention, to the well-being of civilised communities. It was therefore fitting that, in his recent presidential address to the Washington Academy of Sciences (Journal, 1924, vol. 14, No. 14), Dr. T. W. Vaughan gave a prominent place to a consideration of the origin of limestones.

Limestones occur among the sedimentary rocks, and must have been comparatively scarce, in the bedded form in which we know them, during the early stratigraphical history of the earth. R. A. Daly, indeed, thinks that the ocean-waters of pre-Cambrian times were limeless, and to that condition attributes the absence of fossil remains of calcareous organisms in strata of pre-Cambrian age. It is more probable, however, that any precipitation of calcium carbonate that took place in the earth's primeval ocean-waters left the ocean far from limeless; and it seems more reasonable to attribute the absence of calcareous fossil remains in pre-Cambrian strata either to the evolution time-factor, or to metamorphism of the limestone, rather than to the limeless condition of pre-Cambrian ocean-waters.

Igneous rocks represent the ultimate source from which the lime now found in limestones has been largely derived. The average igneous rock of the earth's crust contains about 5 per cent. of lime. The disintegration of rocks by atmospheric agents is accompanied by the solution of the lime in surface waters, chiefly as bicarbonate and sulphate. The precipitation of calcium carbonate in the sea is effected chiefly by the action of calcareous organisms such as foraminifera (especially globigerina), corals, molluscs, and calcareous algæ.

The importance of globigerina as limestone builders was amply proved by the *Challenger* Expedition, from the results of which it was estimated that globigerina ooze covers an area of about 50 million square miles of the ocean floor, *i.e.* about a quarter of the total surface of the earth. The globigerina ooze passes gradually at greater depth into the red-clay deposits which also cover an area of about 50 million square miles. The globigerina ooze itself contains on an average only about 65 per cent. of calcium carbonate, and incorporates within itself a considerable amount of "colloidal mud" similar in character to the red clay of greater depths. Dr. Vaughan enumerates four sources from any or all of which this "colloidal mud" of globigerina ooze and other oceanic deposits may be derived, namely, (1) outwash from the land; (2) volcanic and other dust precipitated from the atmosphere; (3) the residue from the tests of dead pelagic organisms after these tests have been more or less completely dissolved while falling to the bottom; and (4) the mineral residue from the decomposed soft parts of organisms, some of which may be plankton.

Recent analyses of bottom samples of globigerina ooze collected off the American coasts show that the percentage of calcium carbonate decreases as the depth increases, a fact established previously, in a general way, by the work of the *Challenger* Expedition. The rule is not invariable, however; for, as shown by J. Chumley in a recently published paper (Trans. Roy. Soc. Edin., 1924, vol. 54, pt. 1), the amount of calcium carbonate increases with the depth in some areas. In this connexion, Dr. Vaughan emphasises the fact that limestone of a high degree of purity, containing 95 per cent. or more of calcium carbonate, is usually formed either in shallow or only moderately deep water, and states that the purest limestone is deposited in very shallow water. The statements made in some text-books to the effect that globigerina ooze consists of pure calcium carbonate, and that pure limestone is a deep-sea deposit, are misleading.

The degree of purity of shoal-water limestones depends on the amount of outwash from the land. Where there is no outwash of terrigenous material, a beach deposit may contain more than 95 per cent. of calcium carbonate. The oolites of Key West and the Bahamas, which have been formed in shallow water, contain more than 99 per cent. of calcium carbonate. According to Dr. Vaughan, none of the deep-sea oozes approximate to this degree of purity; but J. Chumley records in one instance 97 per cent. at a depth of 2492 fathoms.

Pure shoal-water limestones appear to be chemical precipitates. They are deposited extensively as particles of "colloidal" size in the vicinity of Florida Keys, where storms give rise to a milky appearance in the water, due to the stirring up of the calcareous precipitate. The calcareous matter of the precipitate consists chiefly of fine particles and aggregates of aragonite. Some coarser foraminifera and molluscan shelly matter are present, but it is characterised chiefly by its minute acicular crystals of aragonite.

Such chemically precipitated calcium carbonate is formed only under peculiar conditions. It is deposited in shallow and relatively stagnant water which is at times heated by the sun above the normal temperature of the freely circulating ocean-water. A sample of water from the west side of Andros Island, Bahamas, showed a salinity more than two parts per thousand higher than that of the normal ocean-water of the region; and there is a considerable amount of organic matter in the mud. An analysis by E. T. Erickson of the calcareous mud at this locality showed the presence of 89·62 per cent. of calcium carbonate, 1·39 of magnesium carbonate, 0·93 of strontium carbonate, and 0·68 of calcium sulphate. The presence of such a considerable amount of strontia (0·63 per cent.) is a feature worthy of special mention.

Efforts have been made by various workers to prove that the calcareous muds of Florida Keys, and other such deposits, have been precipitated by the action of bacteria. The investigations of Drs. G. H. Drew, K. F. Kellerman, and N. R. Smith appear to have established the fact that bacteria are present and very active in the muds of the Great Bahamas Bank and Florida Keys. These bacteria include *Pseudomonas calcis*, which is denitrifying in its action, and vibrios, some of which are strong ammonifiers, the latter being regarded as the more important as agents of precipitation. Dr. Smith inferred from his elaborate investigations that calcium carbonate is formed from calcium sulphate as a result of the growth of bacteria; and that calcium carbonate is formed in natural sea-water by pure cultures if organic matter is added.

It seems reasonable to admit, as Dr. Vaughan does, that the association of ammonifying bacteria with others producing carbon dioxide may result in the formation of ammonium carbonate, which, reacting with calcium sulphate in solution, causes the precipitation of calcium carbonate. Dr. Vaughan points out, however, that the surface layer of ocean-water in tropical and subtropical regions is saturated with calcium carbonate, and that evaporation during the summer months is sufficient to account for the precipitation of calcium carbonate, without the agency of bacteria. Taking the evidence as a whole, it seems legitimate to infer that, although bacterial precipitation is possible, it is quite unimportant as a cause of deposition of calcium carbonate even under the most favourable conditions, and that bacteria cannot compare with foraminifera, corals, molluscs, and nullipores as limestone builders. THOMAS CROOK.

The German Scientific and Medical Association Meeting at Innsbruck.

THE German Scientific and Medical Association —Gesellschaft deutscher Naturforscher und Ärzte—held its eighty-eighth meeting in Innsbruck, Austria, on September 21-27. Many former members are now technically foreigners, domiciled in places once Germany, now called by other names. Hence a curious sort of superimposed internationality on a German-speaking basis, a formal recognition of foreign members, and a need for passports. The Austrian embassies and consulates offered visas free of charge from Berlin, Rome, Prague, Belgrade, Budapest, Buckarest, Bern, Danzig, Copenhagen, Stockholm and Christiania. A very emphatic welcome was given in Innsbruck by the Austrian President, Dr. Hainisch, in the name of the republic, and by Dr. Schneider, Minister of Education, for the Government and by others. There were more than 7000 ticket-holders, including a very few Englishmen, among whom were Prof. G. H. Hardy from Oxford and Prof. G. Barger of Edinburgh. The organisation arrangements seemed excellent. The programme was a pamphlet of 24 quarto pages with a very long list of papers, well cross-referenced to joint sessions, and mutual invitations between the 33 separate sections. The ground covered was similar to that of a British Association plus a British Medical Association meeting. The professors of the University of Innsbruck have fitly inaugurated their new buildings. All who co-operated with them, not forgetting the schoolboys who handed out programmes or wore ribbons and met travellers at the station, are to be congratulated highly on the success of their efforts.

The more popular addresses, corresponding to British Association evening lectures, were taken on the first three mornings of the week. These included Dr. Penck on the aspect of the Alps, Dr. Sommerfeld and others on the Bohr atom model, Dr. Porsch on the pollination of flowers by birds, and Dr. von Frisch on the senses and "language" of bees. Experiments have been made in training bees to feed on coloured paper. They appear to recognise colours, including violet, but scarlet is as black to them. The flower-birds visit bird-flowers with the same range of colours as their own plumage; these include red, yellow, and blue. Dr. Knoll has been watching the humming-bird hawk-moth by a proboscis-track method. He finds that after visiting one flower it leaves tiny traces of sugar water on the next object it touches. Dr. Frisch has followed the bees more exactly in an observation hive where each separate insect was marked and numbered consecutively. He says that bees finding honey report their luck to the hive by a special waddling dance. Their comrades are then stimulated to go out and hunt for flowers with the same scent as the honey brought home.

Among numerous communications to the sections were papers on cellulose, the rôle of alkaloids in the life of plants, sweet taste and chemical constitution, fractional distillation and the non-separation of chlorine isotopes, electrolytic conduction in molten alloys, the fine structure of fibre stuffs, on cyanamides, cyanogen compounds, the electric iron industry in the Tyrol, rapid telegraphy in ocean cables, the Siemens band-microphone, electric conductivity in rock salt and calc spar at high temperatures, quantitative spectrum analysis, the measurement from aeroplanes of radioactive decay products in the air, the formation of nitric oxide in the electric arc, the structure of the earth at different depths deduced from earthquake wave velocities, earth currents in mountains, deformation of individual crystals, microchemical detection of complex iron compounds in living plant tissues, and so on.

A joint meeting of Section I., Mathematics, and Section XV., Mathematical and Scientific Instruction, has considered the Denkschrift (Memorandum) of the Prussian Ministry of Education on the reorganisation of higher school education in Prussia. The Union of German Mathematical Societies and the German Committee for Mathematical and Scientific Instruction have also assisted. The hours allotted to mathematics and science, out of a weekly total of 29, are, in the higher forms of the Gymnasium, 3 and 2; in the Real-Gymnasium, 3 and 4; in the Reform-real-gymnasium, 3 and 3. A minimum of 4 hours weekly for mathematics is demanded. Since the days of Kant, a Weltanschauung without mathematics is impossible; it is a training in conscientiousness and fidelity in detail. Science is not merely necessary for all higher specialised work, but is a necessary element of culture. It is a discussion about hours in the curriculum such as we knew in England a generation ago. In Berlin the history teachers are also perturbed about the Memorandum. It is a matter of rescuing humanity in the largest sense from the humanities in their narrowest meaning. Both aims and methods in education need humanising.

The interest of the meeting was intensified by simultaneous gatherings of other societies in association with particular sections. Such were the German Mathematikervereinigung, the Gesellschaft für angewandte Mathematik und Mechanik, the Gesellschaft für Epidemiologie, the Kolloid-Gesellschaft, the Gesellschaft für Kinderheilkunde.

A long series of excursions, especially for geographers and geologists, had been arranged for the days before and after the meeting. For some of these, early notice had to be given, as numbers were limited and clear instructions necessary—"only for good walkers . . . 7 hours a day . . . bring food . . . climbing boots . . . hotel meals only in evening . . . perhaps only hay-shed."

There were several exhibitions, the exhibits being chiefly by German and Austrian firms, a large collection of new scientific books, scientific and medical apparatus especially for Röntgen rays and synthetic drugs. The schools showed some exceptionally good geometrical drawing, a subject to which great importance is attached. The most attractive exhibit was a film showing the movements of growing plants by the Badische Anilin- und Soda-Fabrik. Photo-

graphs had been taken at 20 minutes' intervals and the film speeded up. There are plotted diagrams in Darwin's "Movement in Plants," but none of us had ever seen such extraordinary gesticulations before.

Funds did not allow of printed abstracts in advance, but very successful arrangements were made by the Press Bureau. Proof sheets containing the more popular parts of the day's work were ready at the end of the afternoon and were widely distributed to the press. More technical papers were represented by typed abstracts.

The Chemist and the Fermentation Industries.

STREATFEILD MEMORIAL LECTURE.

THE annual Streatfeild Memorial Lecture was delivered at the Finsbury Technical College on Nov. 6 by Mr. Julian L. Baker, who selected as his subject "The Chemist and the Fermentation Industries." It was pointed out that the revenue from beer and spirits accounts for about one-sixth of the total expenditure, and the materials from which beer and spirits are made are almost wholly derived from agriculture and for the major part from materials grown in Great Britain. It will, therefore, be apparent that the commercial products of fermentation are derived from biochemical industries of vast extent and of enormous economic value. The very small amount of exact knowledge concerning the changes which starch and proteins undergo during the preparation of malt from barley and the mashing process was referred to, also the difficulties which underlie such investigations. An outline was given of work being conducted under the auspices of the Research Scheme of the Institute of Brewing. Much of this is being done at the Rothamsted, Wye and East Malling Research Stations under the direction of Sir John Russell, Mr. Salmon and others. Prof. Pyman, of the Municipal School of Technology, Manchester, is responsible for the chemical work on the constituents of hops, and the direction of other researches is entrusted to certain other college laboratories.

It is not easy to convince the principals of an industry which is essentially empirical in character that, as knowledge increases, the old order *pari passu* changes. The British instinct is to leave well alone. The endowment of research should be regarded by manufacturers as an insurance. Neither is it reasonable for an industry to expect results from scientific researches which will affect immediately manufacturing operations, or an improvement of output. The success of a brewer is gauged by his product, and, as he is essentially a craftsman, his reluctance to experiment on anything but a small scale can be understood. Such considerations as these militate in no small degree against the generous financing of research.

Reference was made to the manufacture of alcohol and to the "Amylo" process, which cannot be used in England owing to regulations enforced by the Board of Customs and Excise; also to the products, such as glycerol, formed by *S. cerevisiæ* from sugar under certain abnormal environmental conditions, and the production of lactic and butyric acids from sugar by bacterial fermentation. The industries based on the activity of micro-organisms are of profound importance to the community, and the fields of investigation both academic and technical in such industries are limitless.

At the conclusion of his lecture, Mr. Julian Baker referred to the recent decision of the City and Guilds of London Institute to close the College in 1926. The withdrawal of the London County Council grant of 10,000*l*. per annum, to take effect in 1926, was largely responsible for the position. He thought the decline in the number of students, given as a reason for the grant withdrawal, had been unduly exaggerated and was no greater than might be anticipated in view of the action taken in 1920 to close the College and admit no new students in the session 1920–21. Immediate action was necessary on the part of those who valued the real and practical educational facilities offered by the College for the last 46 years, due in the first instance to the curriculum provided in chemistry and engineering by its first teachers, Armstrong, Perry and Ayrton. The practical courses unfettered by any particular examination syllabus should be continued, and it was to be hoped that an influential deputation of manufacturers and educationists would find a way to enable the College to continue its work.

Mr. A. Chaston Chapman considered that the sound practical training, with freedom from examination syllabuses, the great tradition of its past students and teachers, and the service it has rendered should assure the continuance of Finsbury, while Prof. G. T. Morgan pointed out that the goodwill of the College and traditions associated with it could not be continued elsewhere.

Prof. H. E. Armstrong gave an account of his early work at Finsbury with Perry and Ayrton, and emphasised the value which the training had always had in promoting the application of science to industry. The College started under the influence of men like Sir Frederick Bramwell, Lord Halsbury and Sir Owen Roberts, and the courses for training chemists and engineers were unique. Chemical engineering was no new subject at Finsbury. All its chemists received training in the principles of engineering as part of the ordinary course.

Prof. F. G. Donnan, who was unable to be present, sent a letter, in the course of which he said: "The whole cause of higher education in London is suffering at present from the want of autonomy in the principal colleges as regards the examination for the B.Sc. Degree. The old Finsbury system was and is the only one which produces good results, and is in fact the method employed by other civilised countries with the exception of England." Mr. F. H. Carr, who also spoke, agreed that the training offered at Finsbury was of great value to the industries. He considered that we are suffering greatly from what he termed the respectability of degrees.

Mr. A. J. Chapman, president of the Old Students Association, gave an interesting account of the work now being done by the Association to save the College.

University and Educational Intelligence.

CAMBRIDGE.—The Botanic Garden Syndicate reports that with the aid of a further generous gift from Mr. Reginald Cory, it is proposed to provide a house for the Director of the Garden. The Local Lectures Syndicate has presented its fifty-first and last report, it having been superseded by the new Board of Extra-Mural Studies. The report makes reference to the loss suffered by the cause of adult education through the death on Mount Everest of Mr. Leigh-Mallory, Assistant Secretary for Lectures, and also through the death of Prof. H. V. Stanton and Prof. R. G. Moulton.

The Lees-Knowles lectures on military science are being given by Lieut.-Col. F. Nosworthy, on Russia before, during, and after the Great War.

Mr. D. R. Hartree and Mr. E. A. Watkins have been elected to fellowships at St. John's College.

The following have been elected to serve on the

Council of the Senate :—The Master of Corpus Christi and the Master of Sidney Sussex, Sir Ernest Rutherford (Trinity) and Prof. A. E. Brooke (King's), Mr. J. F. Cameron (Gonville and Caius), Mr. F. A. Chase (Trinity Hall), Mr. J. M. Keynes (King's), and Dr. P. H. Winfield (St. John's).

For the fifth year in succession Trinity College announces the offer of a Research Studentship open to graduates of other universities who propose to come to Cambridge in October next as candidates for the degree of Ph.D. The value of the studentship may be so much as 200*l.* a year if the pecuniary circumstances of the successful candidate require so large a sum. Applications must reach the Senior Tutor of the College by July 25, 1925. The College is also offering, as usual, Dominion and Colonial Exhibitions of 40*l.* or (in cases of special need) about 72*l.* to students of Dominion and Colonial universities who wish to come to Cambridge next October as candidates for the degree of B.A., M.Litt., M.Sc., or Ph.D. Candidates must apply through the principal authority of their University, and applications should reach the Senior Tutor of the College (from whom further particulars may be obtained) by July 1, 1925.

GLASGOW.—Prof. H. H. Dixon, whose appointment by the Crown to the Regius chair of botany in the University was recently announced, has intimated to the Secretary for Scotland that, for private reasons, he is unable to accept the appointment. The chair is therefore still vacant, and steps will be taken in due course to make another appointment.

OXFORD.—On November 4, Convocation approved the nomination of Dr. H. Eltringham, New College, as a Curator of the Hope Collections.

A decree has passed Congregation authorising the expenditure of 3000*l.* towards the expense of providing a joint lecture-room, library, and workshop for the Departments of Physiology and Biochemistry.

ST. ANDREWS.—At a meeting of the University Court on October 31, Mr. A. M. Adamson was appointed assistant in the Department of Zoology at St. Andrews, in succession to Mr. D. R. R. Burt.

APPLICATIONS are invited by the Birmingham Education Committee for the headship of the Engineering Department of the Birmingham Municipal Technical School. The necessary form of application, with particulars of the appointment, may be had from the principal of the school, or the Chief Education Officer, Education Office, Margaret Street, Birmingham.

AN article on "Safeguarding the Health of University Students in Europe," by Jean Willems, Secretary of the University of Brussels, appears in the July number of the Review of that University. Brief accounts of what is being done in this matter in other countries are followed by a somewhat fuller description of the work of the German university students' mutual-aid associations and other organisations with which they co-operate. One of the questions they have taken up is that of annual medical examinations. In Dresden, Tubingen, Giessen, Heidelberg, Stuttgart, and Münster-in-Westphalia, schemes for promoting such examinations have been established, generally on a voluntary basis. Students whose health has suffered through being obliged to engage in manual work in order to support themselves while studying, have been sent during the past year to the number of some hundreds for rest cures to rest-homes established for the purpose, where they are treated free of charge by the local physicians. Tuberculous students have been the object of special solicitude. In the autumn of 1923, 160 were lodged in sanatoria for consumptives at the expense of mutual-aid associations and with the collaboration of the German Red Cross Association.

THE Calendar for 1924–25 of University College, London, includes in a thirty-page section devoted to post-graduate courses of lectures a prospectus of work in the new Ramsay Department of Chemical Engineering, the object of which is "to enable young graduates in Chemistry *or* Engineering, who have already obtained a good training in the fundamental sciences of Chemistry, Physics and Mathematics, to direct their studies and investigations towards the application of the principles of Physical Chemistry to the scientific design and operation of the apparatus and processes of chemical industry in general." The second year of the two-year course will be devoted to original research in the laboratories or at industrial works, and will include lectures dealing with the lay-out of plants and factories, factory administration, and industrial economics. The Provost's report mentions that a record of the achievement of a hundred years of work is being prepared for the celebration to take place in 1926. Some strong comments are made by the Dean, of the Faculty of Medical Sciences, and endorsed by the Provost, on the present organisation of medical examinations in the University of London: "We are fettered by a rigid system of examinations which was devised to ensure the attainment of a least common standard in a number of different schools unfortunately this system, with even greater certainty checks any advance beyond such a minimum standard." A movement within the University for bringing these examinations more closely into line with modern teaching is in progress. Appended to the report is an address by the Rt. Hon. Edward Wood on the effect of education on public opinion.

WRITING on "Pioneer Medical Women" in the *Fortnightly Review* for November, Mrs. Fenwick Miller recalls the fact that when the first British Register of Medical Practitioners was established by Act of Parliament in 1858, there was no medical examination open to women in Great Britain, and that the one woman whose name appeared in that register, Elizabeth Blackwell, had obtained her medical education in the United States, at the University of Geneva in the State of New York. After taking her degree she came to England to study at St. Bartholomew's Hospital, where she was admitted to all departments except that of the diseases of women, the professor of which subject "entirely disapproved of a lady studying medicine." She returned to the United States and founded a hospital there and a medical school for women. Miss Elizabeth Garrett (Mrs. Garrett Anderson) qualified for the Licentiate of the Apothecaries Society in 1865, but shortly afterwards the Council of the Society took measures to prevent any other women from following this example. The true pioneer of medical women in Great Britain was Sophia Jex-Blake, born in 1840, and the greater part of the article is devoted to an appreciation of her career—one which fulfilled de Vigny's definition of "une grande vie," namely "une pensée de la jeunesse exécutée par l'âge mûr." She early formed a determination "not to seek a medical career for herself alone, but to open the road to an equal medical standing with men for all other women who wished to follow." The story of her indomitable persistence in pursuing this aim is a stirring one—painful, too, by reason of the discreditable character of much of the opposition she encountered. Her greatest achievement was the establishment of the London School of Medicine for Women, which has this year celebrated its jubilee.

Early Science at the Royal Society.

November 16, 1664. The Secretary produced a small French book, written by father Charles Burgonis against Monsieur Pascal's treatise of the equilibrium of liquors and the weight of the air. The president took it home for his perusal, in order to give an account of it to the society.

1667. Mention being made, that a security might be provided for such inventions or notions, as ingenious persons might have, and desired to secure from usurpation, or from being excluded from having a share in them, if they should be lighted on by others; it was thought good, if any thing of that nature should be brought in, and desired to be lodged with the society, that, if the authors were not of their body, they should be obliged to show it first to the president, and that then it should be sealed up both by the small seal of the society, and by the seal of the proposer; but if they were of the society, then they should not be obliged to shew it first to the president, but only to declare to him the general heads of the matter, and then it should be sealed up, as mentioned before.

1676. Mr. Oldenburg communicated a third letter to himself from Signor Cassini, acquainting the society with some of the astronomical observations made in 1672, by Mons. Rocher, at Cayenne in America, whither he had been sent by the Royal Academy of Sciences at Paris.

1681. The president (Sir Christopher Wren) discoursing concerning the library of the Society, promised to give five pounds to be expended on books of geometry.

November 18, 1663. Mr. Palmer presented the society with a very artificial gun of Caspar Calthof's contrivance, lodging at a time seven bullets and powder in proportion, and discharging them at seven several times. He had the thanks of the society; and it was ordered, that he should be registered as a benefactor. Sir Robert Moray mentioned, that prince Rupert had contrived a gun exceeding all that had hitherto been invented of that kind, discharging several bullets with ease and without danger. Sir Robert Moray was desired to request prince Rupert to send his powder-tryer with a loose and fixed ferrel to the society, to try his experiments of the force of powder therein.

November 19, 1662. Dr. Charlton gave an account of making the powder for embalming birds, and preserving them and their feathers to the life. He was desired to communicate in writing the whole process, according to the relation made by him.

1668. Mr. Oldenburg read a letter from the vice-chancellor of the university of Oxford to Mr. Boyle, importing, that he would endeavour to procure an exchange of the manuscripts now in the possession of the society, for such books as were proper for their purpose. — Mr. Oldenburg produced the curiosities sent from the Bermudas which he had lately retrieved, after having been missing for several weeks, the captain of the ship, to whom they had been recommended, not remembering what was become of them.

November 20, 1673. The lord bishop of Salisbury acquainted the Society, that those eminent citizens of London, who had been formerly deputed by the City and the Mercers' company to invite the Royal Society to return to Gresham College, viz., Sir John Laurence, Sir Richard Ford, Sir Thomas Player, and Mr. Rowland Wynne, had, upon occasion expressed, that they should esteem it as an honour to be elected into the Royal Society: whereupon his lordship now proposed them all four as candidates.

Societies and Academies.

LONDON.

Royal Society, November 6.—T. R. **Merton**: On ultra-violet spectro-photometry. A "neutral wedge" of platinum can be used for measurements of radiations so short as $\lambda = 2100$A. These "wedges" require to be calibrated, both as regards the thickness of the platinum as a function of the distance from the thin end of the wedge, and as regards the density gradient for a given change in the thickness of the platinum as a function of the wave-length. The density gradient is sensibly constant from $\lambda = 4000$A to $\lambda = 2500$A.—W. L. **Bragg** and S. **Chapman**: A theoretical calculation of the rhombohedral angle of crystals of the calcite type. The structure of calcite found by X-ray analysis is built on a series of rhombohedral cells, the edges of which meet at an angle of 101° 55′. Other carbonates and sodium nitrate have a very similar form. The rhombohedral angle of about 102° which is present in all cases is not fixed by the symmetry. The angle has been calculated by a consideration of the equilibrium of the calcite structure. It is assumed that the electrostatic forces correspond to those between a charge of $+2e$ at the centre of the calcium atom, $-2e$ at the centre of the oxygen atom, and $+4e$ at the centre of the carbon atom, and that the force of repulsion is directed from the electrostatic centre of each atom. The crystal is given a deformation which does not alter the distance between neighbouring atoms, so that the forces of repulsion do no virtual work. The electrostatic energy for each configuration is then calculated and a value for the rhombohedral angle found which makes the energy a minimum. This is the condition for equilibrium. The rhombohedral angle so calculated differs by 3° or 4° from the observed value. The alteration in rhombohedral angle, when one metal is substituted for another, is very exactly explained.—O. W. **Richardson** and T. **Tanaka**: (1) The striking and breaking potentials for electron discharges in hydrogen. There are three types of discharge from a thermionic electron-emitting cathode in hydrogen at pressures below 1 mm. The striking and breaking potentials for the discharge which sets in at the lowest voltages have the following properties: (*a*) They fall to a limit as the electron emission of the cathode increases; (*b*) these limiting values have a minimum for a pressure which depends on the electrode distance; (*c*) as the electrode distance is diminished the minimum values of the breaking potential approach a lower limit asymptotically. This limit coincides with the strongest ionisation potential of hydrogen. Spectroscopic evidence is adduced in favour of the view that the type of ionisation which occurs at this point is the splitting of an electron from the hydrogen molecule with the formation of ionised H_2. A considerable number of the lines in the secondary spectrum are selectively affected as regards intensity in the different types of discharge. (2) On a P, Q, and R combination in the many-lined spectrum of hydrogen. Starting from a study of the lines of the secondary hydrogen spectrum which are selectively weakened in a thermionic discharge tube at pressures less than 1 mm., we have been able to arrange 24 lines of this spectrum as members of series, with the designations $P(1) \ldots P(9)$, $Q(1) \ldots Q(5)$ $Q(7)$ $Q(8)$, $R(1) \ldots R(9)$; 15 of the lines satisfy the combination principle

$$P(m+1) + R(m\ 1) = Q(m+1) + Q(m)$$

to within 0·38 wave-number or less. Two others satisfy it to within 0·86. One of these is known to be a blend, and probably the other is also. The

term numbers are not accurately represented by the theoretical formulæ of Kramers and Pauli. The calculated initial and final values of the moments of inertia of the emitters of these lines are $6{\cdot}24 \times 10^{-41}$ and $4{\cdot}80 \times 10^{-41}$ gm. cm.^{2} respectively, and it is probable that the emitter is something heavier than H_2, perhaps H_3.—J. D. **Bernal**: The structure of graphite. The structure of graphite has been examined by the method of the rotating single crystal. The structure is essentially that of Hull, but with all the carbon atoms lying in the cleavage plane, as in the Debye and Scherrer model.—P. L. **Kapitza**: α-ray tracks in a strong magnetic field. Photographs by the Wilson cloud method of α-ray tracks have been taken in magnetic fields of 40,000 to 80,000 gauss. The tracks are curved, and give values for the ratio of the average charge to the velocity of an α-particle at various points along its range. The differences in curvature between individual tracks are probably due to the natural curvature of α-particle tracks.—C. N. **Hinshelwood** and R. E. **Burk**: The homogeneous thermal decomposition of nitrous oxide. The bimolecular nature of the thermal decomposition of nitrous oxide into its elements has been confirmed by a more conclusive method than that previously used by Hunter. The reaction is homogeneous from 838° abs. to 1125° abs. and uncatalysed by platinum or rhodium. The observed rate of reaction can be interpreted in terms of simple thermal activation of the molecules by collision.—C. N. **Hinshelwood**: The kinetics of the interaction of nitrous oxide and hydrogen. The rate of interaction of hydrogen and nitrous oxide has been investigated in the absence of catalysts and in the presence of platinum. The rate of reaction on a platinum wire was followed by measuring the change in the thermal conductivity of the gas mixture as the reaction proceeds. Hydrogèn forms a film on the platinum which retards the reaction. Nitrous oxide reacts with hydrogen when it enters the gaps in this film. The latent heat of evaporation of the film of adsorbed hydrogen, inferred from the effect of temperature on the rate of reaction, is about 25,000 calories per gram molecule.—A. T. **Doodson**: Perturbations of harmonic tidal constants. An examination of the results of analyses of tidal records, as expressed in the so-called "harmonic constants," shows the influences of tidal friction, while one of the perturbations examined has importance in connexion with the dynamical theory of tides in oceans. Some secular changes show that the tides are diminishing in range at some places and increasing in range at other places; changes in the basins of the seas are suggested in explanation.—K. R. **Ramanathan**: The structure of molecules in relation to their optical anisotropy. Pt. I.—R. W. **Wood**: Controlled orbital transfers of electrons in optically excited mercury atoms. Mercury vapour, *in vacuo* at room temperature, is optically excited by illumination by radiation of wave-length 2536. This raises the electrons from the $1S$ orbit to the $2p_2$ orbit. Simultaneous illumination by one or more monochromatic radiations raises the electrons to high levels. From these levels they return to the inner orbits, the vapour radiating wave-lengths corresponding to the orbital transitions involved. By comparing the intensities of the spectrum lines obtained in this way, statistical data regarding the probability of definite transitions under specific conditions may be obtained. Remarkable effects have been observed when helium, nitrogen, and other gases are mixed with the mercury vapour. The addition of nitrogen at 2 mm. pressure causes a thirty-fold increase in the intensity of the green light ($\lambda = 5461$) emitted by the vapour. In this case the phenomenon was found to be associated with the absorption of the line 4046, which is not absorbed at all by optically excited mercury vapour *in vacuo*. The nitrogen apparently brings the electrons on to the $2p_3$ orbit (instead of $2p_2$), for all lines corresponding to transfers from outer orbits to $2p_3$ are powerfully absorbed by the mercury vapour when it is simultaneously illuminated by the 2536 line. Other lines and bands appear with the arc lines of mercury, when other gases are present, notably the great "water-band" in the vicinity of the mercury lines 3125-3131.

Aristotelian Society, November 3.—Prof. A. D. Lindsay, president, in the chair.—Presidential address: What does the mind construct? Many attempts have been made to describe knowing as a process in which the mind is passive, but all have broken down before the fact that at least in error there is something which the mind itself has brought into being. There is, however, a type of mental constructing done in the service of knowledge which alters neither knower nor what is known. The map of a country is a physical reality in the same meaning as the country it represents, and apprehended in the same way, yet it is a mentally constructed thing. This kind of mental construction is possible because there are parts of reality, our bodies, for example, which we control and vary, and other parts over which we have little or no control. These mental constructions which aid us to understand are not copies of the reality they represent; they are diagrams containing in an apprehensible form the elements we want to study. The same is true of mental images, which are the work of constructive imagination. They are of the same kind as models or maps or words. Images involve for their existence a body with a mind and objects external to and acting upon that body. Wherever there is anything of which we can ask whether it is true or false, there is something made by the help of our body, of which we can be aware in the same way as we are aware of the reality to which it refers and to which, if true, it corresponds.

SHEFFIELD.

Society of Glass Technology, October 15.—Col. S. C. Halse, president, in the chair.—Prof. W. E. S. **Turner**: The present position of the glass industry in North America. The cut glass industry has almost entirely died out in America, but coloured glass is growing more important. Pot furnaces are disappearing in favour of tank furnaces. The latter are now being used even for the manufacture of green and blue signal lights, and for selenium ruby glass. Electric light bulbs are practically all made by machines fed from tank furnaces, the glass being the soda-lime-magnesia type. The tubing required for the completion of the lamp is still of the lead glass variety. An epoch-making process for the manufacture of sheet glass is that developed at the glass works of the Ford Motor Company. The glass is melted in tanks, and there is continuous rolling between a pair of rollers, the sheet passing down a lehr about 440 ft. long and afterwards, in sheets, traverses long tables on a continuous belt, where the grinding and polishing are done. The average life of a tank furnace operated by machines is 11 to 13 months. Several factories can show a ratio of fuel consumed to glass produced so low as 0·6.

PARIS.

Academy of Sciences, October 20.—M. Guillaume Bigourdan in the chair.—Henry Le **Chatelier**: The allotropy of glass (p. 731).—Jules **Andrade**: The hypothesis of practical chronometer makers and the method of Résal-Caspari.— **Berloty**: The total

xpse of the moon of August 14, observed at the Kura Observatory (Libau). Details of results ɔlained with the 20 cm. equatorial and with an r cm. telescope.—Edouard **Imbeaux**: The great esian basins of the United States.—Johs **Schmidt**: e immigration of the larvæ of the eel, in the Mediterranean, by the Straits of Gibraltar (*v.* NATURE, January 13, 1923, p. 51, and January 5, 1924, p. 12). —ules **Drach**: The movement of a heavy solid with point fixed. Determination of the group of rionality of the differential equation of the problem. —René **Garnier**: The uniform functions defined by inversion of total algebraical differentials.—G. Viron: Complements to the Picard-Borel theorems. —Serge **Bernstein**: The quasi-analytical functions of Holmann.—Bertrand **Gambier**: A generalisation of the polygons of Poncelet.—J. **Grialou**: Plane vertical vement of liquids possessing viscosity, the state ng permanent.—Benjamin **Jekhowsky**: The ments of the planet Algiers N (1924 QL).—J. Gillaume and Mlle. **Bloch**: Observations made at the Lyons Observatory during the eclipse of the on, August 14, 1924.—W. **Abbott**: The breaking- of the southern polar cap of Mars.—J. **Guillaume**: servations of the sun made at the Lyons Observa- ry during the first quarter of 1924.—R. **Jouaust**: e amplification of the current of photoelectric ls and its application to precision astronomy. It possible with simple arrangements to determine a photographic recorder the time of transit of a ght star if the telescope is of sufficient size. If ry sensitive photographic galvanometers are used, ch as a string galvanometer, smaller telescopes may used for observations on less bright stars.—Nicolas Frrakis and Pierre **Bedos**: A law connecting the isation potential of an element with its boiling int. A formula is given for the relation between e ionisation potential and boiling point and the lues calculated for fifteen elements. The calculated d experimental values are in fair agreement, with e exception of the two elements oxygen and nitrogen. -A. **Dufour**: The wave-length of maximum energy the sound spectrum of an explosion. Analysis of e records of the sound wave of the Courtine explosion ves results in agreement with the theory of M. llard, that the wave-length of maximum energy i the sound spectrum of an explosion varies with the ass of explosive employed.—Mlle. Irène **Curie** and bbuo **Yamada**: The distribution of the length of e α-rays of polonium in oxygen and in nitrogen. om the results described, it follows that the difference form between the Bragg curves in oxygen and in trogen must be attributed to the law of variation ionisation along an α-ray.—Georges **Chaudron** ad Hubert **Forestier**: The allotropy of the oxides iron, chromium, and aluminium.—C. G. **Bedreag**: hysical system of the elements.—A. **Duboin**: The icate compounds of cadmium. The compounds $_2O$. CdO . $4SiO_2$, 2CdO . SiO_2, and 3CdO . SiO_2 ve been isolated.—M. **Risco**: Spectrum analysis the meteorite of June 19, 1924. The meteorite as shown to contain magnesium, aluminium, silicon, otassium, calcium, titanium, vanadium, chromium, anganese, iron, cobalt, nickel, strontium, and ossibly barium.—David **Rotman-Roman**: Some olcanic rocks of the Yémen. Analyses and descrip- ons of comendite and plagitrachyte.—Gustave ivière and Georges **Pichard**: Contribution to the udy of the immediate principles contained in apple aves and the epidermis of apples. The *malol* tracted by Sands from the skin of apples is an id-alcohol, and is re-named by the authors maloloic id.—F. **Picard**: Contribution to the study of the nysiological rôle of the tannins. Their importance the ripening of the shoots of the vine.—Marc **Bridel**: The fermentation hydrolysis of gentiacauline. Preparation of a xylo-glucose, primeverose. Two ferments have been prepared capable of hydrolysing gentiacauline, one prepared from the seeds of *Rhamnus utilis*, the other from *Monotropa Hypopitys*. Both give the same products, gentiacauleine and a new xylo-glucose probably identical with the primeverose of Goris, Mascré, and Vischniac.—H. **Lagatu** and L. **Maume**: A remarkably regular evolution of certain physiological ratios (lime, magnesia, potash) in the leaves of a well-manured vine.—L. **Léger**: An organism of the parasitic Ichthyophone type in the digestive tube of *Lota vulgaris*.—G. **Guittonneau**: The utilisation of mineral nitrogen by the Microsiphoneæ of the soil.—Auguste **Lumière**: Contribution to the study of normal sera.

Official Publications Received.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 8: Het Klimaat van Nederlandsch-Indië (The Climate of the Netherlands Indies). Door Dr. C. Braak. Deel 1 (Vol. 1), Algemeene Hoofdstukken (General Chapters), Aflevering 6 (Part 6). (With English Summaries.) Pp. iv+343-415+159-198. (Batavia: Javasche Boekhandel & Drukkerij.)

Journal of the Chemical Society: containing Papers communicated to the Society. 1924, Vol. 125, October. Pp. iv+1971-2197+xii. (London: Gurney and Jackson.)

Monographs of the Rockefeller Institute for Medical Research. No. 20: Experimental Studies of Yellow Fever in Northern Brazil. By Dr. Hideyo Noguchi, Dr. Henry R. Muller, Dr. Octavio Torres, Dr. Flaviano Silva, Dr. Horacio Martins, Dr. Alvaro Ribeiro dos Santos, Dr. Godofredo Vianna, and Dr. Mario Bião. Pp. 36+5 plates. (New York City.)

Bulletin of the Experiment Station of the Hawaiian Sugar Planters' Association. Entomological Series, Bulletin No. 16: The Introduction into Hawaii of Insects that attack Lantana. By R. C. L. Perkins and O. H. Swezey. Pp. iii+83. (Honolulu, Hawaii.)

Contributions from the Jefferson Physical Laboratory and from the Cruft High-Tension Electrical Laboratory of Harvard University, for the Years 1922 and 1923. Vol. 16. 47 papers, unpaged. (Cambridge, Mass.: Harvard University.)

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 7, No. 4: Some Digestibility Trials on Indian Feeding Stuffs. By Dr. P. E. Lander and Pandit Lal Chand Dharmani. Pp. 77-100. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 12 annas; 1s.

The Parliament of the Commonwealth of Australia. Meteorological Service: Report to the Right Honorable the Minister for Home and Territories in the Meteorological Service of the Commonwealth for the Year 1922-1923. Pp. 18. (Melbourne: H. J. Green.) 9d.

Memoirs of the Asiatic Society of Bengal. Vol. 6: Zoological Results of a Tour in the Far East. Edited by Dr. N. Annandale. Part 9: Fish of the Talé Sap, Peninsular Siam (Part 1), by Dr. Sunder Lal Hora; Fish of the Tai-Hu, Kiangsu Province, China, by Henry W. Fowler; Revision of the Japanese Species of the Genus *Corbicula*, by Dr. B. Prashad. Pp. 461-530. (Calcutta.) 3.6 rupees.

Battersea Polytechnic. Report of the Principal for the Session 1923-24. Pp. 36. (London: Battersea, S.W.11.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 46: Four new Species of Coccidæ from Egypt. By W. J. Hall. Pp. ii+8+6 plates. (Cairo: Government Publications Office.) 5 P.T.

Proceedings of the Royal Irish Academy. Vol. 36, Section B, No. 12: The Glacial Geology of the North-West of Ireland. By Prof. J. Kaye Charlesworth. Pp. 174-314+plates 8-9. 8s. 6d. Vol. 36, Section B, Nos. 13, 14, 15, 16: Dichromone and Dibenzyldichromone, by Dr. Joseph Algar, Francis Fogarty and Dr. Hugh Ryan; The Condensation of Aldehydes with Butylacetoacetic Ester, by Dr. Hugh Ryan and Mary J. Shannon; The Condensation of Aldehydes with Methylethylketone, by Dr. Hugh Ryan and Patrick J. Cahill. Pp. 315-339. 1s. 6d. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Methods and Problems of Medical Education. (First Series.) Pp. 151. (New York City: The Rockefeller Foundation.)

Diary of Societies.

SATURDAY, NOVEMBER 15.

BRITISH MYCOLOGICAL SOCIETY (in Botany Department, University College), at 11.—Dr. W. Robinson: Conditions controlling Growth and Reproduction in Sporodinia.—A. W. Exell: Hymenial Structure in Three Species of Stereum.—W. J. Dowson: A Die-back of Rambler Roses caused by *Gnomonia Rubi* Rehm.—Miss Clara A. Pratt: The Staling of Fungal Cultures.—J. Ramsbottom: Fragmenta Mycologica.

PHYSIOLOGICAL SOCIETY (at London Hospital Medical School), at 4.—I. Sands: Self Oxidation in the Blood of the Earthworm.—Dr. J. M. H. Campbell, G. O. Mitchell, Dr. M. S. Pembrey, and A. T. W. Powell: The Effect of Muscular Work upon Digestion.—Dr. M. S. Pembrey: The Weight of the Heart in Different Conditions.—Dr. W. Cramer: Self Control and Inhibition in the Adrenal.—Dr. A. V. Anrep and Prof. E. H. Starling: Central and Reflex Regulation of the Circulation.—Prof. H. E. Roaf and W. A. M. Smart: Some Equations based on the Application of the Mass Law to Oxyhæmoglobin Dissociation Curves.—J. R. Marrock: Comparison of Chloride and Iodide Excretion in

Nephritis.—I. de Burgh Daly: A Closed Circuit Heart-Lung Preparation.—Dorothy Patrick: Some Effects produced by the Hooding of Birds.—N. Burgess: The Comparison of Maternal and Fœtal Blood Sugar after the Second Stage of Labour.—Dr. C. S. Myers: A Theory of Sensory Adaptation.

MONDAY, NOVEMBER 17.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—J. D. Cockcroft, R. T. Coe, J. A. Tyacke, and Prof. Miles Walker: An Electric Harmonic Method of Analysis.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—Major E. G. Beaumont: The Maintenance of Commercial Vehicle Fleets.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. Bagenal: Planning for Good Acoustics.

SOCIETY OF CHEMICAL INDUSTRY (London Section, Joint Meeting with the Institution of the Rubber Industry) (at Engineers' Club, Coventry Street, W.), at 8.—Dr. A. van Rossem: Latex: its Chemistry and the Development of its Industrial Applications, followed by a discussion opened by B. D. Porritt.

FARADAY SOCIETY (at Chemical Society), at 8.—R. W. E. B. Harman and F. P. Worley: The Hydrolysis of Alkali Cyanides in Aqueous Solution.—Prof. A. P. Laurie: Note on the Expansion of Water while freezing.—S. S. Joshi: The Viscosity of Reversible Emulsions.—D. B. MacLeod: (*a*) The Viscosities of Liquids at their Boiling Points; (*b*) The Kinetic Theory of Evaporation.—J. T. Howarth and F. P. Burt: New Design for Apparatus to measure the Coefficient of Deviation from Boyle's Law, and the Determination of this Coefficient for Acetylene.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Capt. M. W. Hilton-Simpson: The People of the Aures Massif.

TUESDAY, NOVEMBER 18.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—G. Udny Yule: The Growth of Population and the Factors which control it (Inaugural Address).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of October 1924.—L. C. Bushby: Exhibition of Specimens from the Caird Insect House.—A. N. Rankin: Exhibition of Photographs taken during the Oxford Spitsbergen Expedition.—M. Burton: A Revision of the Sponge Family Donatidæ.—P. R. Lowe: The Anatomy and Systematic Position of the Madagascan Bird Mesites.—Sir Frederick Mott: Notes on the Gibbon Larynx made during Dissection.—Dr. Ekendra Nath Gosh: The Anatomy of *Parallelipedum* Klein (Mollusca).

INSTITUTION OF CIVIL ENGINEERS, at 6.—W. J. Hadfield: Notes on Modern Practice in Road-making.

ROYAL SANITARY INSTITUTE, at 6.—Miss J. B. N. Paterson and others: Discussion on the Economic Value of the Healthy Infant and the New Zealand Welfare Work to the State.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. McGovern: The Influence of Internal Combustion Engines on the Design of Merchant Ships.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at the College, Loughborough), at 6.45.—W. Lawson: General and Technical Ideas from the Experience of a Meter Engineer.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at 17 Albert Square, Manchester), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—A. P. H. Trivelli, E. P. Wightman, and S. E. Sheppard: Note on the Relationship of Photographic Emulsion Fog to Grain Size.—S. E. Sheppard: Grain Size and Distribution in Emulsions.—L. F. Davidson: Conditions governing the Behaviour of the Silver Bromide Grains during Development.—Cambridge Instrument Company, Ltd.: Demonstrations of the Cambridge Photographic Ophthalmoscope and the Cambridge Record Measuring Machine.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Star and Garter Hotel, Wolverhampton), at 7.30.—Major E. G. Beaumont: The Maintenance of Commercial Vehicle Fleets.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—Discussion on paper entitled A Proposed Form of Bow Construction, by E. F. Spanner.—G. Austin: A New Electric Drive for Ship and other Auxiliaries.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Reports on Important Events during the Vacation (World Power Conference, Conference on Illuminating Engineering at Wembley, Meeting of International Illumination Commission, International Conference on Industrial Hygiene, etc.), and Developments in Lamps and Lighting Appliances.

ROYAL ANTHROPOLOGICAL INSTITUTE (at London School of Economics, Houghton Street, W.C.), at 8.15.—Capt. M. W. Hilton-Simpson and J. A. Haessler: Native Life in the Algerian Hills.

WEDNESDAY, NOVEMBER 19.

SOCIETY OF GLASS TECHNOLOGY (at Leeds), at 2.30.

BRITISH CAST IRON RESEARCH ASSOCIATION (at Institution of Mechanical Engineers), at 3.30.—Annual Meeting.

MEDICAL SOCIETY OF LONDON, at 5.—Dr. H. Spencer: The Renaissance of Midwifery (Lloyd Roberts Lecture).

ROYAL METEOROLOGICAL SOCIETY, at 5.—Sir Gilbert Walker: Note on Bjerknes's Contribution of 1921 to the Mechanics of the General Circulation.—W. H. Dines: The Correlation between Pressure and Temperature in the Upper Air, with a suggested Explanation.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.

INSTITUTION OF CIVIL ENGINEERS (Students Meeting), at 6.—P. W. Thomas: Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.

ROYAL SOCIETY OF ARTS, at 8.—L. B. Atkinson: The Scientific Principles of Artificial Incubation.

INSTITUTE OF CHEMISTRY (London Section), at 8.—Dr. J. J. Fox and V. Stott: Discussion on the Standardisation of Scientific Glassware, with Particular Reference to Units of Volume.

INSTITUTE OF CHEMISTRY AND SOCIETY OF CHEMICAL INDUSTRY (at Caledonian Station Hotel, Edinburgh), at 8.—Prof. G. G. Henderson: The Profession of Chemistry.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND PROGRESS (at Essex Hall, Essex Street, W.C.), at 8.—Dr. C. W. Saleeby: Heredity and Degeneracy—some New Discoveries (to be followed by discussion).

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—G. R. de Beer: Comparative Histology and Cytology of the Pituitary Body.—Miss J. Latter: The Development in Lathyrus.—Dr. W. N. F. Woodland: Some Remarkable Caryophylloids from Siluroid Fishes of the Sudan.

THURSDAY, NOVEMBER 20.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IR... (at 11 Chandos Street, W.), at 2.30.—Dr. G. de M. Rudolf: M... Treatment of General Paralysis—some Psychological and Ph... Observations.

ROYAL SOCIETY, at 4.30.—Prof. J. Barcroft, M. L. Anson, A. E. M... and S. Oinuma: The Correlation between the Spectra of v... Hæmoglobins and their Relative Affinities for Oxygen and C... Monoxide.—H. R. Hewer: Certain Abnormalities occurring ... Pituitary of the Frog.—*To be read in title only*:—A. Howard: The ... of Grass on Trees.—Dr. J. W. Pickering and Dr. F. E. Taylor: ... Coagulation, Anti-Coagulants and Hæmolysis.—R. J. Ludford: ... Distribution of the Cytoplasmic Organs in Transplantable T... Cells: with special reference to Dictyokinesis.—E. Ponder: The Ba... like Structure of the Mammalian Erythrocyte.—V. B. Wigglesw... Uric Acid in the Pieridæ: a Quantitative Study.—Dr. G. Li... Johnson: Contributions to the Comparative Anatomy of the Re... and the Amphibian Eye, chiefly based on Ophthalmological Examin...

LINNEAN SOCIETY OF LONDON, at 5.—Prof. F. W. Oliver: Then and ... Photographs taken after Several Years' Time.—C. J. Wills: Eobu... a Fossil Scorpion.—J. R. Norman: Blind Cave Fishes.—Miss ... Blackwell: *Cytisus Adami*.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at ...

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—G. Rogers: Auto... and Semi-Automatic Mercury-Vapour Rectifier Substations.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates Me... (at Watergate House, Adelphi), at 7.30.—D. S. D. Williams, ... Harris, and others: Discussion on the Motor Cycle Show.

CHEMICAL SOCIETY, at 8.—F. Challenger, J. R. A. Jinks, and J. Ha... The Sulphur Compounds of Kimmeridge Shale Oil. Part ... Challenger and T. H. Bott: The Interaction of Thiocyanogen a... Hydrogen Sulphide with Insaturated Compounds. Part II.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at London S... of Hygiene and Tropical Medicine, Endsleigh Gardens) (Labor... Meeting), at 8.15.—Demonstrations by Major Austen, Dr. Broug... Alcock, Dr. H. B. Day, Capt. W. H. Dye, Dr. Drbohlav, Dr. ... Hanschell, Dr. W. E. Haworth, Col. S. P. James, Col. Clayton ... Mr. Ll. Lloyd, Dr. Manson-Bahr, Dr. H. B. Newham, Col. M... Perry, Dr. J. Harvey Pirrie, Dr. H. H. Scott, Surgeon Comm... T. B. Shaw, and A. L. Sheather.

INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Section ... Birmingham).—F. W. Suffield: The Design of an Up-to-date Facto...

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Section) (at ... chester).—W. S. Burge and P. J. Chittenden: Reducing or Pa... Turbines.

FRIDAY, NOVEMBER 21.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool ... versity), at 6.—J. L. F. Vogel: Notes on Alloy Metals used in ... Steels.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Report of the M... Oil-Engine Trials Committee.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), ...—W. H. Ashbee: Photographic Exhibitions and the Public.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. G. Hopcraft: Sta... Steel.

INSTITUTE OF METALS (Sheffield Local Section) (at 198 West S... Sheffield), at 7.30.—A. Marks: Non-Ferrous Metals in the Foundr...

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUI... (Middlesbrough Graduate Section) (at Cleveland Institute, Mid... brough), at 7.30.—R. H. Dealtry: Motor-Cycle Carburation.

INSTITUTION OF MECHANICAL ENGINEERS (Liverpool Section) (at I... pool).—W. S. Burge and P. J. Chittenden: Reducing or Pas... Turbines.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 15.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. H. S. Harr... Evolution and Darwinism.

TUESDAY, NOVEMBER 18.

ROYAL BOTANIC SOCIETY OF LONDON, at 3.—Prof. Bickerton: ... Forces of Nature.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: The Philosoph... the Absolute in English Thought (1). Bosanquet's Philosoph... Reality and Value.

GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy. (Succe... Lectures on November 19, 20, 21.)

WEDNESDAY, NOVEMBER 19.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Prof. J. B. Co... Smoke (Chadwick Lecture).

THURSDAY, NOVEMBER 20.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Dr. J. S. Edkins: The Caus... of Sex.

KING'S COLLEGE, at 5.30.—O. V. Salomón: Peru, Old and New (1). ... Ancient Civilisation of Peru.

FRIDAY, NOVEMBER 21.

KING'S COLLEGE, at 5.30.—Prof. E. G. Coker: Scientific Method.

SATURDAY, NOVEMBER 22.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: S... Life among Insects. II. Butterflies and Moths.

NATURE

SATURDAY, NOVEMBER 22, 1924.

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON

Science, the Church and Disease.

THERE appears to be little or nothing recondite in the widely advertised dispute concerning missions of "spiritual" healing which has developed within the Church of England. The point at issue was expressed with great clearness and ability by a committee of the Lambeth Conference at the beginning of the year. That committee was at great pains to define its attitude towards the problem which had been submitted to its consideration. It strove boldly and without equivocation to set forth its view of what "spiritual" meant or could mean in relation to the cure of disease. It was to mean primarily and principally a healing of the "spirit"—and the committee explicitly set aside the claims of spiritual healers to any power not evidenced as strongly in ordinary medical practice by persons who professed no religious belief. The committee emptied the ritual of all meaning save as a suggestive technique, but recommended its use.

It is clear, however, from recent events at Bradford and London, that the situation is one of grave concern to many highly placed members of the Church. The Bishop of Manchester says the cures among those who attended the Bradford Mission were "rather few in proportion to the number of cases attending." Dean Inge, in the course of a vigorous protest against "the craze for miracle-mongering, which is part of a widespread recrudescence of superstition among the half-educated," says "only those who have attempted to sift the evidence for a miraculous cure know the shuffling and prevarication with which they are met. In nine cases out of ten the evidence breaks down utterly." Other dignitaries of the Church have uttered warnings which sound merely gloomy and indistinct beside the ironical sentences of the Dean. Their conjoint testimony is sufficient to lead us to the conclusion that a superstitious tendency is being combated by enlightened and informed leaders.

In so far as respect has been shown for the method and results of science, there is no cause for complaint but rather some for satisfaction. If we minimise it, we do so because we are aware that science does not advance either in discovery or in its place in the life of the people merely in proportion to the applause or even the popular assent which it receives, but because each of its revelations constitutes itself at its birth part of man's environment. If any one believes that in certain circumstances of miraculous intervention there are no limits to the suggestibility of the individual human being, positive knowledge will soon come to correct him unless he is right.

Faced with the astounding evidence of credulity which newspaper discussions and public conferences

afford, it is not easy to get near to those aspects of the matter which are important. One of the chief seems to us to be the connexion which undoubtedly exists between the present outbreak of "submerged belief"—to use Dean Inge's phrase—and the so-called "new" psychology. At least one physician of repute has expostulated with even the more sympathetic groups in the Church on the ground of their too ready assumption that Freudian psycho-analysis means modern psychology and neurology. It remains to be seen whether the imposing verbiage now current under the description of Freudian psychology will yield up a single significant fact concerning the mental or physical behaviour of human beings. It spread widely and wildly in Great Britain in company with other "psychical" teachings like Jung's and those of the Nancy school during and after the War because those who very nobly rescued certain of our troops, in the teeth of a reluctant War Office, from the stigma of asylum treatment, had to invoke the authority of a "new" psychology to do so. The recognition of suggestion as a therapeutic agent amounts to little more than the conversion of its unconscious use into a conscious and premeditated use with possibly diminishing success. Technically no resource of the psychotherapist could surpass the "healing" mission in the creation of a favourable atmosphere. If, as the Bishop of Manchester says, the cures are few, we have at least some evidence of the scope for this treatment.

The discussion of "healing" missions brings home the wide interest in psychology albeit ill-informed and misdirected. May it not be, however, that many of the extravagances of the present time might be avoided if sound scientific knowledge were more accessible not to the public alone but also to the medical profession itself? Much has been done of late to bridge the gulf between the medicine of the body and the medicine of the mind; but much remains to be done. Surely it is now time that the science of behaviour should be taught by those who know what is known concerning the organism that behaves. Yet we believe there is not more than one school in London where that could be done soundly and thoroughly.

The interposition of a pseudo-science between biology and its practical application in medicine would, at this stage in the age-long and arduous fight for the liberation of medicine from magic, lead to disaster. It is such an interposition that we are witnessing in the practice of medicine by laymen whether under a religious or a "psychical" guise. The extrusion of such doctrines from scientific medicine and the elaboration of a sound medical psychology can be secured only by giving to psychology its rightful place in the hierarchy of the biological sciences.

Origin and Structure of the Earth.

The Earth: its Origin, History, and Physical Constitution. By Dr. Harold Jeffreys. Pp. x+278. (Cambridge: at the University Press, 1924.) 16*s.* net.

DR. JEFFREY'S book on the earth will be very welcome to the many who are interested in the larger dynamical aspects of our planet, in its present and past states. The book may be divided roughly into three nearly equal parts, dealing respectively with the origin and past history of the earth (considered as a basis for conclusions about its present condition), the theory of isostasy and of the surface features, and finally, various miscellaneous subjects—seismology, the figures of the earth and moon, tidal friction, and the variation of latitude. Despite the generality of the title given to the book, many branches of geophysics are not touched on at all—terrestrial magnetism and electricity, general tidal theory, and meteorology. This was almost inevitable in a book of comparatively small size, particularly since its aim is not to be merely descriptive, but rather to give in some detail the mathematical reasons for the hypotheses adopted.

The first part of the book, on the origin of the earth, overlaps to some extent with Dr. Jeans's recent "Problems of Cosmogony and Stellar Dynamics." The two writers are not in accord on all points, but the degree of agreement is more important than the differences considering that their work has been independent. The earth and other planets are supposed to have been formed by condensation from a gaseous fragment of the primitive sun, torn off from the nearer of the two tidal protuberances raised on the sun during the close passage of a much more massive star. The reasons for rejecting the theory of break-up under the influence of rotation alone are given in a chapter on Laplace's nebular hypothesis.

Jeans has shown that, in order to explain the relatively small mass of the planets compared with that of the sun, the disrupted body must have been highly condensed towards its centre. This seemed to necessitate that the primitive sun must, at the time of the break-up, have been in the giant stage, and on this basis the author sets, as a lower limit to the radius of the sun at that epoch, a distance equal to one-seventh the radius of the present orbit of the earth. He supposes, in fact, that the sun, though far larger than now, was well within the present orbit of Mercury. Jeans, on the other hand, supposed that it extended beyond the present orbit of Neptune; the author gives his reasons for preferring the smaller size. Since the book was written, however, Eddington has cast serious doubt on the view, hitherto tacitly accepted, that the substance of dwarf stars is not in the state of a perfect

gs; if it is, then a dwarf star is as highly condensed wards its centre as a giant star, and the above method fixing a lower limit of size for the sun at the time of eak-up seems to fail.

The further history of the earth is described as llows: it probably became solid near the surface ithin 15,000 years, but remained too hot for the ndensation of water vapour until much later, when ie sun had cooled through the giant stage and become dwarf, probably of type Fo. Geological time starts about this point, when the oceans were formed: and extends over the period of cooling of the sun from ype Fo to its present type Go. Astrophysical reasons e given for supposing that this second period is perhaps n times as long as the pre-geological period, so that ie duration of geological time is nearly equal to ie whole age of the earth. Various methods of stimating this age are given, which roughly agree in dicating a period of a few thousand million years. he most trustworthy method is that based on the anium-lead ratio in the earth's crust.

The thermal history of the earth is worked out on he assumption that the conductivity and other thermal roperties of the rocks affected are independent of epth, that is, of changes of pressure and temperature. Experimental evidence is inconclusive on this point. he result thus arrived at is that below a depth of 00 km. no appreciable cooling has yet occurred, hile at about 300 km. it amounts to between 200° nd 300° C. These figures refer to the part covered by and, the cooling under the oceans being somewhat reater. The physical state of the matter at great epths has therefore probably remained unaltered ince the earth first condensed, that is, it is liquid, nable to transmit distortional waves, and indefinitely eformable by long-maintained shearing stresses. At ntermediate depths, such as 300 km., the rocks will e rigid but probably not "strong," that is, they may e capable both of vibration and flow, like shoemaker's ax. At 100 km. depth the rocks are likely to be ery rigid in the ordinary sense of the term. The earing of these conclusions on the theory of isostasy is considered in detail.

In his discussion of the very controversial question of the method of formation of mountains, the author definitely concludes that the thermal contraction of the earth's crust is a sufficient cause. He estimates the probable reduction of the crust surface by contraction at four thousand million square kilometres, and the reduction necessary to account for the known mountains at half this area. The contraction is supposed to have proceeded gradually until the compressive stresses reached the yield point, mountains then being formed by surface fracture and crumpling. The fractures got sealed up and a period of quiet ensued until further contraction again raised the stresses to the breaking point. Periods of mountain formation thus alternated with quiet periods, and the author estimates, on the basis of his theory, that about six such alternations have occurred hitherto.

Owing to the greater cooling beneath the oceans (which is estimated as being 300° more, at 100 km. depth, than at the same depth under the land, while the sub-oceanic surface of the crust is maintained at a uniform temperature), it is suggested that the crust must have buckled beneath the oceans, the edges being bent downwards. In this way the ocean deeps are explained: in almost all cases they occur near the edges of the great oceans. The rise of extensive areas of sedimentation is also connected with the same phenomenon: the sediments will be deposited round the edges of the land masses, accentuating the tendency of the edges of the sub-oceanic crust to sink, and thereby also increasing the strain at the boundary between the ocean bed and the continental part of the crust. If fracture occurs, the oceanward side of the crust will be more free to bend downward further, but on the landward side of the fault the weight of the sediment may be insufficient to hold down the crust, which may therefore rise and bring the sediments above sea-level.

In the chapter on seismology the theory of earthquake waves is developed directly from the theory of elastic waves in a solid, assuming that the rigidity of the material of the crust increases considerably at a moderate depth (the discussion of the cooling of the crust had already suggested such a change, by indicating that at 10 to 20 km. depth the outer layer of acidic granitic rocks gives place to heavier basic rocks of greater rigidity); and that the underlying strata are sufficiently heterogeneous to cause a good deal of internal reflexion. But the velocities and paths of earthquake waves are still very uncertain, largely because the depth at which earthquakes originate is unknown.

The influence of tidal friction on the rate of rotation and orbital motion of the earth, moon, and other planets and satellites affords one of the most interesting and successful chapters in the theory of planetary dynamics. In the case of the earth, the subject has been put on a really satisfactory footing by Prof. G. I. Taylor's discovery of the paramount importance of tidal friction in shallow seas, supplemented by the author's discussion of the dissipation of energy in the various shallow seas of the globe. The relative unimportance of bodily tidal friction is shown by the persistence of the Eulerian nutation (modified by elastic yielding), as evidenced by the 14-monthly component of the variation of latitude. But the

variability of the amplitude of this component suggests that some damping exists, and also, consequently, some yet unexplained source of regeneration. The variation of latitude also has an annual component which is not adequately accounted for.

The book ranges over so wide a field of knowledge that probably no one critic can be competent to assess the probability of the many hypotheses adopted by the author as a result of his discussions; the process of sifting or confirmation must be left to the efforts of many workers over a long interval. The book might have been improved if Dr. Jeffreys, by means of references to further literature at the end of each chapter, had made it easier for his readers to examine for themselves the sources of observational evidences and the opinions of other writers. Again, some discussion might have been given of the probability of differences of internal motion in the earth, either as set up in the fragments initially torn off from the sun, or induced afterwards through unequal yielding of the earth to tidal retardation, as recently suggested by Eddington; such internal motions would, it is known, be very slowly dissipated by viscosity, and they might have important geophysical effects. But a desire for more information on the subjects discussed in the book must be regarded as a compliment rather than a criticism of the author, whose able and interesting exposition is likely to stimulate further investigation into the problems upon which his own work enables him to write with so much authority and insight.

The Protection of Timber in the Sea.

Marine Structures: their Deterioration and Preservation. Report of the Committee on Marine Piling Investigations of the Division of Engineering and Industrial Research of the National Research Council. By William G. Atwood and A. A. Johnson; with the Collaboration of William F. Clapp, of Robert C. Miller, and of H. W. Walker, H. S. McQuaid and Marjorie S. Allen. Pp. vi + 534 + 14 plates. (Washington, D.C.; National Research Council, 1924.) 10 dollars.

THE deterioration of engineering structures exposed to the action of the sea is at present being investigated by two important research organisations. In Great Britain, a committee of the Institution of Civil Engineers, acting under the Department of Scientific and Industrial Research, was established in 1916 and has issued three interim reports which have already been noticed in NATURE (October 21, 1920, p. 235; December 30, 1922, p. 878; and November 17, 1923, p. 741). In the United States a committee was appointed in 1922 by the National Research Council, following an inquiry by a local committee on a d vastating outbreak of shipworm in timber structur in San Francisco Bay in the years following 1914. Th report of this American Committee, now publishe records a great mass of observations and experiment ably digested and summarised by Col. Atwood, M A. A. Johnson, and their collaborators. While th general scope of the inquiry is the same in both case the American investigators have given less attentio than have their British colleagues to the corrosion c metal structures and have devoted themselves mor particularly to the problem of protecting timber fro the attacks of marine boring animals.

The Committee has realised the need for precis systematic determination of the animals causing dam age, and considerable space is devoted in the repor to the description and illustration of the numerou species of wood-boring Mollusca and Crustacea foun in American waters. Of the molluscan shipworms about two dozen species are named and a number o other forms are recorded which may prove to b distinct species. It is of interest to note that th European *Teredo navalis* is recognised as "one of th most widely distributed as well as one of the mos destructive," occurring both on the Atlantic and or the Pacific coasts of the United States. This is no in agreement with the views of Dr. Bartsch, of th United States National Museum, who has stated tha no shipworm found on the coast of the United State can be identified with any species occurring in othe parts of the world. The zoologists of the Committee appear less inclined to apply the Monroe doctrine to systematic zoology, and they acknowledge a number of immigrants among the Teredinidæ.

The point is not without some practical as well as theoretical interest. It is a characteristic feature in the biology of the shipworms that from time to time they make their appearance in numbers in places where they had not previously been noticed; and it is no less characteristic that, when this happens, "practical men" always begin by attributing their appearance to importation from abroad. Thus Linnæus, when he called the shipworm "Calamitas navium, ex Indiis in Europam propagata," was expressing the common opinion of the eighteenth century, and, quite lately, the destructiveness of *Teredo navalis* in the United States has been attributed to its recent importation from Europe. Perhaps, in some cases, the practical men were right, especially in the old days when wooden ships came home from long voyages with timbers "almost spongy with decay." It is very likely, however, that, more often, excessive multiplication has merely directed attention to a pest that had lurked in odd corners unnoticed because harmless. Sometimes

it s possible to trace the cause of this multiplication in some change of the physical conditions, as the San Francisco outbreaks were found to follow years of deficient rainfall leading to increased salinity of the harbour waters. For many outbreaks, however, no obvious cause can be assigned. Perhaps, as in many other cases, it has been too readily assumed that the increasing or decreasing abundance of a species must be due to man's interference with Nature or to the mutability of weather. It is easy to forget that a fauna is not a fixed unchanging thing but a swaying balance of opposing forces in which now one and now another species may have the higher hand.

The business of the engineer, however, is to find some means of defending his handiwork against possible disaster, and a great part of the report is occupied by an exhaustive discussion of methods that have been used or suggested for warding off the attacks of marine timber-borers. Some kinds of wood are much more resistant than others, but the numerous records here collected and tabulated do not encourage hope that any will be found permanently immune. Methods of protecting timber by means of paints and other surface applications have been investigated, as well as more elaborate and expensive processes of casing the piles with metal or concrete, some of which have given good results. Many processes of impregnating wood with various substances have been tested, and much study has been devoted to creosote impregnation, the most efficient of the methods actually in use. It is pointed out that "after the shipworms have become established and their development has proceeded beyond the larval stage, they seem to work only little less freely in creosoted than in uncreosoted timber," so that the protective value of creosote is due to its action on the larvæ.

In the United States, as in England, the investigators have turned the experiences of warfare to account in their search for poisons that may be used to impregnate wood, and a long and interesting section of the report is contributed by the Chemical Warfare Service. The toxicity of some 45 compounds was tested on larval and adult shipworms and on the crustacean Limnoria. It may be recalled that the British investigators obtained the best results with a substance which they termed phenarsazine, the "D.M." of poison gas warfare. If this be the same as diphenylaminechlorarsine, which the American report identifies with "D.M.," it is remarkable to find that it is here rated very low on the scale of toxicity. It is not included in the list of seven compounds of which it is stated that "between these solutions and all the others there is a decided increase in effectiveness." Experiments are in progress to test the degree of protection given by these and other substances when used for impregnating wood, but these experiments have not yet gone far enough to give conclusive results.

The Committee records two authentic instances of concrete being seriously damaged by rock-boring mollusca. One of these was in the Panama Canal zone, and the damage was mainly due to Lithophaga, a borer which appears to disintegrate the concrete by chemical action. At Los Angeles, on the other hand, the chief agent was a species of Pholadidea, belonging to a family of mechanical borers, which rasp away the rock with their shells. In this case it is not surprising to learn that "a sample of the best mortar in which the borers were found could be readily cut with the thumb-nail."

The report concludes with a bibliography extending to 61 pages closely printed in double columns. It is admirably done and will be of great assistance to future workers. It appears to approach completeness as nearly as any bibliography can; the industry of the compilers has even extended to quotations from the Septuagint and the Vulgate, but the relevance of the passages quoted is not apparent, at least in the Authorised Version. W. T. C.

Laws and Customs in Central Africa.

(1) *The Laws and Customs of the Yoruba People.* By A. K. Ajisafe. Pp. vi+97. (London: G. Routledge and Sons, Ltd.; Lagos: C.M.S. Bookshop, 1924.) 3*s.* 6*d.* net.

(2) *The Bagesu and Other Tribes of the Uganda Protectorate: the Third Part of the Report of the Mackie Ethnological Expedition to Central Africa.* By the Rev. Canon John Roscoe. Pp. xiv+205+32 plates. (Cambridge: At the University Press, 1924.) 20*s.* net.

(3) *White and Black in East Africa: a Record of Travel and Observation in two African Crown Colonies.* By Hermann Norden. Pp. 304+18 plates. (London: H. F. and G. Witherby, 1924.) 15*s.* net.

THE authors of the three books under notice approach their subjects from three entirely different points of view. Mr. Ajisafe is a Yoruba native who puts forward a treatise upon the laws and customs of his own people: Canon Roscoe and Mr. Norden write as foreigners visiting Africa, but, again, their points of view differ. Canon Roscoe is a trained ethnologist; his expedition was organised for the purpose of obtaining information useful to anthropological science. Mr. Norden writes as a tourist, relating the experiences of a pleasure trip in Kenya and Uganda.

(1) The work of Mr. Ajisafe is an extremely useful compendium of the legal and social system of his countrymen; the ordinances of the Yoruba, based upon

age-long tradition, appear to be both just and merciful. Take as an example the following :

" A child's mother being a slave or captive, the child inherits in greater proportion than those children whose mothers are free-born, for the children of the free-born have maternal sides to inherit from while the child of a captive or slave wife has none."

The Yoruba king was, apparently, by no means absolute, and his ministers were responsible to the people for his conduct. In certain cases they could depose him, requesting him to " sleep," that is, to die. The king had " power to declare war, and even send and commission any of his military subjects to wage war against a certain town or tribe." If, however, his subjects were defeated, it seems that it was necessary for him to " sleep " before the unsuccessful expedition returned home. Some of the laws seem strange to us ; for example, the wearing of socks except by " Egungun " was forbidden by native law ; an offender was liable to a heavy fine, imprisonment, or even death.

No less strange was the ordinance " Should a cock in transit crow at the town gate, it is seized and confiscated by the toll collector, the owner in addition to this paying 1*s.* 1*d.* Both the cock and the fee belong solely to the collector."

The book is useful as a record of native customs in a country where European influence is fast increasing. The scientific reader will regret that there is no index, and no adequate vocabulary of native terms.

(2) Canon Roscoe's book is a collection of notes on various tribes, chiefly in the neighbourhood of Mount Elgon, about which, even now, little is known. The first seven chapters deal with the Bagesu, one of the most primitive tribes in Africa. Chapters viii.-xiii. deal with the semi-pastoral Basabei. A chapter is next devoted to the Nilotic Bateso, concerning whom Canon Roscoe has already given us some information in his book " The Northern Bantu." The following four chapters are concerned with the Basoga, with whom the above-mentioned work also deals in part. Further chapters treat of the Bakonjo, the Bambwa, the Bakuntu, and Batuse.

Perhaps the most interesting section of the book is constituted by the chapters on the little-known semi-pastoral Basabei, living upon the north and north-east slopes of Mount Elgon. This tribe observes a system of compensation for murder which is highly unusual. In the case of a fight between two members of the same clan resulting in the death of one, no compensation could be claimed by the parents of the dead man ; but if the deceased were married, his wife's parents were entitled to a cow and a sheep.

" Should the murderer and his victim be of different clans, the clan of the murdered man would demand compensation. The murderer brought to an appointed place ten cows, and two bulls, and members of bo clans met there. One bull and one sheep were kill for the men, and the same for the women, and the cla ate a meal together and were smeared with the co tents of the stomach and some of the blood of t animals. The spear, shield, and knife of the murder man were brought and given to his brother, who al took the skin of one bull and one sheep, while t brother of the murdered man's wife took the rest."

As the tribe practised clan exogamy, the clan of t murdered man obtained next to nothing, and the cl of the victim's wife were the chief gainers. This see inexplicable, unless a husband worked for his wife family, and on his death the latter required a indemnity. Further study of this tribe may affo an explanation.

It would be of interest to have a medical accou of the very drastic form of circumcision perform during the initiation ceremonies of the youths of th tribe. It seems incredible that, immediately after severe an operation as Canon Roscoe describes, t boys should be able to engage in a dance.

It is much to be regretted that folklore relating domestic animals amongst primitive people has be rarely collected. Although in Europe much has be recorded concerning bees and bee-keeping, little h been written by ethnologists on the subject of be culture, and the taboos connected therewith among primitive tribes. Therefore, the information recorded pages 171-2, concerning the taboos observed before t collecting and eating of honey amongst the Bakyiga, very welcome. Canon Roscoe is to be congratulated up the completion of a series of extremely useful report

(3) Mr. Hermann Norden's book is readable a illustrated with good photos. It covers his journ through Kenya and Uganda on the way to the Cong and we hope to hear of his further adventures, aft leaving British territory, in a later volume. T author had perused the records of hunters, missionari and explorers and determined upon obtaining firs hand impressions of this part of Africa. Accompani by his friend Lewis, he entered by way of Zanzibar a Nairobi, and, striking inland, visited the famo troglodyte natives of Mount Elgon for one hou finding this survey sufficient. Many tribes were aft wards visited, and the travellers record their presen at many dances, in most of which the transatlan eyes of Mr. Norden beheld indecency. A fuller accou of the Ja-Luo people, the Nilotic branch of the Ka ondo, is given than of any other tribe, and it is evid that a special study of these folk is needed.

Mr. Norden was appreciative of the work of t British white officials, and seems to have enjoy himself thoroughly. LOUIS C. G. CLARKE.

Our Bookshelf.

Handbuch der biologischen Arbeitsmethoden. Ed. Prof. Dr. Emil Abderhalden. Abt. XI.: *Methoden zur Erforschung der Leistungen des Pflanzenorganismus.* Teil 1, Heft 7 (Schluss), Lieferung 134. *Experimentelle Physiologie der Pflanzenzelle.* Von Ernst Küster. *Serum-Reaktionen zur Feststellung von Verwandtschaftsverhältnissen im Pflanzenreich.* Von Carl Mez. Pp. 961-1123 + xxiv. (Berlin: Urban and Schwarzenberg, 1924.) 6·75 gold marks.

An almost uncanny ingenuity seems to have been shown by the distinguished editor of this series in devising the subjects for monographic treatment, and in attempting the discussion of the experimental physiology of the plant cell, the author has almost inevitably taken refuge in banalities. There is a brief section upon material, which may be summarised as stating that unicellular organisms are more convenient for use and that tissue culture experiments with plants have so far been singularly unsuccessful.

Under the section upon testing material there is a brief discussion of the use of plasmolysis, staining, etc., to determine the vitality of the material under examination. The main part of this monograph may be useful as bringing together data upon a number of different technical methods scattered widely through the literature and including the isolation of microscopic organisms for examination, measurements of growth of single hyphæ, plasmolysis, following the internal movements of certain cell constituents or chloroplasts, the influence of light, centrifugal force, narcotics, etc., upon the cell and its component parts. Micro-dissection methods are briefly referred to, but more space is given to a number of out-of-the-way experimental methods which would certainly be buried in the literature but for this monograph.

The brief monograph upon serum diagnosis is confined strictly to a practical account of the method as employed by Mez, who has injected plant extracts into dogs and afterwards, by the use of precipitin and agglutinin reactions with serum from the animal, investigated extracts of other plants as to their biochemical similarity, relying upon the specific nature of the protein chemistry of these reactions as shown by the experience of animal physiology. This biochemical method is thus employed as a test of relationship as embodied in the current classification of the plants. Work of this nature has filled many pages of German and Japanese botanical journals in recent years, but so far has been left alone by British workers.

Pighude (*Echinodermer*). Af Th. Mortensen. (Danmarks Fauna: Illustrerede Haandbøger over den Danske Dyreverden med Statsunderstøttelse udgivne af Dansk Naturhistorisk Forening.) Pp. 274. (København: G. E. C. Gads Forlag, 1924.) 7·50 Kr.

This little book on the echinoderms of Denmark, by a well-known investigator of the group, is part of a Danish series comparable with the "Faune de France." Considerable progress has been made since the Trustees of the British Museum published the late Jeffrey Bell's "Catalogue of British Echinoderms," but British naturalists will now find their needs almost completely supplied by Dr. R. Koehler's "Echinodermes" and Dr. Mortensen's "Pighude." Between them they cover the English Channel and the greater part of the North Sea. One would have liked some general discussion of the echinoderm fauna as a whole, with its relations to Arctic, Atlantic, and southern faunas, but this book, like Dr. Koehler's, is almost purely descriptive. Two points in which it differs from any previous work of the kind are the description of the larval forms of the species wherever known, and the inclusion of the chief Danish fossil echinoderms. The latter course is practicable for Denmark, because examples are virtually confined to the Chalk. Another useful and unusual feature is the indication of the tonic accent in systematic names, thus: *Soláster éndeca.*

In view of the author's recognised competence it were superfluous to praise the exactitude and clarity of his descriptions, though British readers may get more use from the clear diagrams and photographs with which the book is liberally provided. One does not, perhaps, look in a work of this kind for its author's views on classification; one assumes that a somewhat conservative attitude is adopted for the sake of a wide public. This no doubt explains the retention of Phanerozonia and Cryptozonia as the two orders of starfish, and of Ophiuræ and Euryalæ as the two orders of brittle-stars. Under the sea-urchins we are glad to see the old ordinal name Diadematoidea. In this, as in other features, the book is thoroughly well suited to the working naturalist. F. A. B.

Air Ministry: Meteorological Office. British Meteorological and Magnetic Year Book, 1915. Part 5: *Réseau Mondial,* 1915. *Monthly and Annual Summaries of Pressure, Temperature, and Precipitation at Land Stations, generally Two for each Ten-degree Square of Latitude and Longitude.* M.O. No. 222g (Tables). Pp. xviii+115. (London: H.M. Stationery Office, 1924.) 24*s.* net.

The outstanding feature of this work, gathered from a rough examination, after realising the immense labour in its production, is the valuable step made by the publication of the several annual results towards interpreting aright the causes which influence the weather and its changes in different parts of the globe. The monthly and annual means afford much material for study, especially now that results are available for six years, 1910–1915, and year by year the data are accumulating. For the present volume, observations are utilised for 434 stations. It is to be regretted that so far data from the sea have not been included; over the Atlantic, and somewhat in other oceans, where daily synchronous charts are or can be prepared, observations could be fairly easily obtained. Monthly charts for the several elements would facilitate immensely the study of the material.

The following are typical of some facts to be gathered from the work: the mean pressure results for the year show that the highest mean pressure is 30·22 in. at Tanana in 65° N. and 152° W., the lowest 29·28 in. on the *Endurance* in 73° S. and 44° W. The highest mean temperature for the year is 86° F. at Khartoum in 16° N. and 33° E., the lowest 13° F. at Markovo-sur-Anadyr in 65° N. and 171° E. The greatest annual precipitation is 12,875 mm. (507 in.) at Cherrapunji in 25° N. and 92° E., the bulk of which falls in the four

months May to August. This is more than 20 times greater than the normal for London. A summary is given of the winds at selected stations in the tropics, and notes are inserted on the state of the ice in the Arctic seas and in the North Atlantic Ocean.

Agrikulturchemie. Bearbeitet von Prof. Dr. F. Honcamp; in Gemeinschaft mit Dr. O. Nolte. (Wissenschaftliche Forschungsberichte: Naturwissenschaftliche Reihe, Band 10.) Pp. viii+160. (Dresden und Leipzig: Theodor Steinkopff, 1924.) 0·95 dollar.

THIS small paper-covered volume is a review of the more important investigations in agricultural chemistry published during the years 1914–1920. It is specially intended to help workers who were, perforce, unable to keep in touch with their subject during those years and have not time to go through back numbers of journals. It seems a little late to bring out a summary down to 1920 only; but, in explanation, the editor states that much foreign literature has reached him quite recently.

There are four sections—soils; plant nutrition and manuring; animal nutrition and feeding stuffs; and agricultural chemical methods. Dr. O. Nolte is responsible for the first and last sections. Individual papers are for the most part dealt with very briefly, and the book is written somewhat after the manner of the annual reports to the Chemical Society and the Society of Chemical Industry. Full references are included. The authors show a patriotic bias in their selection of material for mention; but the decision as to what to include in a brief survey of this sort, dealing with a very large amount of literature, must in any case involve a strong personal factor and it is perhaps unreasonable to complain of omissions.

So far as the writer has tested them, the references are accurate and the discussions in the text adequate for the purpose. The book is a painstaking compilation which will prove useful to research workers and teachers of agricultural chemistry.

Manual of Cultivated Plants: a Flora for the Identification of the most Common or Significant Species of Plants grown in the Continental United States and Canada for Food, Ornament, Utility, and General Interest, both in the Open and under Glass. By L. H. Bailey. Pp. 851. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1924.) 31*s.* 6*d.* net.

PROF. L. H. BAILEY has again placed horticulturists in his debt by the publication of his "Manual of Cultivated Plants," in which he has set down the plants commonly grown in N. America, both for use and for their horticultural interest. The book is furnished with keys by which the various species can readily be identified, which are of very great value. The descriptive portion is prefaced by a very useful general account of herbarium methods, terms and names used in botanical science, and a valuable list of the botanists who have given to the plants their specific names. This is followed by a key to the families of the plants referred to in the manual.

The various families are then treated in detail, and concise but adequate descriptions are given of the genera and species. The more important genera or families are illustrated with very useful text figures, which are of considerable value to the plant lover w may not be a professional botanist.

Though the book is written for N. American a Canadian readers, it is not without value to students Great Britain, where most of the plants recorded c be cultivated. It is a model of what such a bo should be to enable plant lovers easily to determi the plants under cultivation in gardens or for econor purposes.

Kant und Einstein: Untersuchungen über das V hältnis der modernen Erkenntnistheorie zur Relativitä theorie. Von Dr. Alfred C. Elsbach. Pp. viii+3 (Berlin und Leipzig: Walter de Gruyter und C 1924.) 8*s.*

THIS book is a study of the important problem of t relation between the space-time theory of Kan "Critique of Pure Reason" and the relativist theo of Einstein. The author, who is of Dutch nationali has already written essays on the subject in his nati language. The present extensive study in German based on the works of the late Hermann Cohen a Paul Natorp, and more especially on the recent wo of Prof. Ernst Cassirer, to whom the book is dedicate Cassirer's "Substance and Function" was reviewed NATURE of August 9, p. 187. The transcendent æsthetic theory of Kant was founded on the classi mechanics of Newton, and intended to give the phi sophical basis of Newton's concepts of absolute spa time, and velocity. There is no more importa problem in contemporary philosophy than to determi whether and how far Kant's doctrine can be adapt to the new physics.

(1) *Immanuel Kant*, 1724–1924: *Gedächtnisrede z Einweihung des Grabmals im Auftrag der Albert Universität und der Stadt Königsberg in Preussen g 21 April 1924 im Dom zu Königsberg gehalten.* V Adolf von Harnack. Pp. 14. (Berlin: Juli Springer, 1924.) 0·25 dollar.

(2) *Immanuel Kant und seine Bedeutung für die Natu forschung der Gegenwart.* Von Prof. Johannes v Kries. Pp. iv+127. (Berlin: Julius Spring 1924.) 0·95 dollar.

THESE two works are issued in connexion with t bicentenary of Kant's birth, recently celebrated in h native city of Königsberg. They were both referr to in our note concerning that event (NATURE, May 1 p. 723). They are now issued separately and convenient form.

Descriptive Labels for Botanic Gardens. By Humphre Gilbert-Carter. Pp. 80. (Cambridge: At the Un versity Press, 1924.) 1*s.* 6*d.* net.

THE booklet of descriptive labels drawn up by th Director of the Cambridge University Botanic Garde is a very useful publication, and it is interesting to se that the practice started at Kew many years ago fo trees has been extended by Mr. Carter to other plants o economic or botanical importance. It may be though that the labels are rather on the "learned" side, bu the inclusion of Arabic and Hindustani words will n doubt be appreciated at Cambridge. Mr. Carter give some very useful suggestions as to methods of prepara tion of these labels in a cheap and lasting manner.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Earth Tides, Ocean Tides, and Local Geology.

I HAVE read with interest Dr. Lambert's letter in ATURE of October 18 with reference to the earth ides observed by means of Hecker's horizontal endulums at Potsdam. These indicated a greater igidity on the earth in a direction a little north of est and south of east. I connected this with the evailing west-north-west and east-south-east strike the folds of the rocks to the south, and probably also those underlying the point of observation.

Dr. Lambert, however, points out that the earth ides are the result of the summation of the effects of ie attraction of the moon and sun on the different oncentric zones of which the earth may be conceived be made up, and contends that as the influence of eological structure does not extend to any great epth, it would not seriously affect the result. It is, n the other hand, possible to show that a higher zone as a greater effect on the tidal movement at the rface than one of the same thickness at a lower level. is easily seen that the direct distortional stress, f, of nar or solar attraction on a zone of the earth's crust proportional to the distance, r, of the zone from the ntre. It is also proportional to the density, ρ, of the ne and inversely proportional to its rigidity, μ. We n therefore write $f = Cr\rho/\mu$ . . . (1), where C is a nstant. But the resulting effect at the surface, F, ill be diminished in the ratio of the area of the zone that of the surface, namely, in the ratio of r^2 to R^2 here R is the radius of the earth. Accordingly $= Cr^3\rho/\mu R^2$. Let C/R^2, which is a constant, be equal to D; then $F = Dr^3\rho/\mu$ . . . (2). But if v is the velocity f the propagation of distortional waves in the zone, e know that $v = \sqrt{(\mu/\rho)}$. Hence $\mu = v^2\rho$. Substituting n (2) we have $F = Dr^3/v^2$ . . . (3). Hence the total ffect of all the zones at the surface $= D\Sigma r^3/v^2$.

Mallet found the velocity in sand to be 0·25 km. er second, and Fouqué and Lévy, that in the Fontainebleau sandstone to be 0·3 km. Dr. Jeffreys and Dr. Vrinch, calculating from the records of the Oppau xplosion, concluded that the velocity of distortional ibrations in typical sedimentary rocks was 0·8 km. nd for the underlying crystalline acid rocks 3·1 km. elow these is a basic magma which extends, it is elieved, down to a depth of nearly 1500 km., and he velocities at different depths have been worked ut by Zoeppritz and Geiger in Germany, and more ecently and accurately by Knott at Edinburgh, from he times of transit of distant earthquake shocks. Knott gives a fairly uniform increase from 3·98 km. er second at the surface to 6·88 at a depth of 1449 km. t is probable, however, that these figures do not pply to sedimentary and acid crystalline rocks near he surface.

Below 1449 km. the velocity varies but little down o 4449 km. This is probably not because the rigidity s constant but because the density increases. The listortional waves cannot be traced to greater depths, ut the effect at the surface of tidal action in this egion must be comparatively unimportant.

We do not know the composition of the rocks at lifferent depths at Potsdam, but to form a general idea of the probable effect at the surface of tidal ction in different zones, we may make a reasonable ssumption of their thickness.

The surface formation at Potsdam consists of unconsolidated sand, and this and similar materials probably extend down to a considerable depth. The velocity near the surface would be about 0·25 km. per second. Let us assume that in the first 2 km. it averages 0·3 km. and that in the next 3 km. of more consolidated sedimentaries 0·8 km. per second, and then for 15 km. in acid crystalline rocks, 3·1 km. per second. Below 20 km. the velocities are taken to be those given by Knott.

The following table shows the velocities at different depths on the above basis and the values of r^3/v^2 indicating the relative tidal effects, at the surface of the earth, of the lunar (or solar) attraction on zones of equal thickness at each depth.

EFFECT ON SURFACE OF TIDAL ACTION IN CONCENTRIC ZONES.

Depth in km.	Radius in km.	Velocity of Distortional Waves, in km. per sec.	r^3/v^2 divided by 10^2.
0* to 2*	6,378 to 6,376	0·3	2,883 to 2,880
2* to 5*	6,376 to 6,373	0·8	405·0 to 404·4
5* to 20*	6,373 to 6,358	3·1	26·94 to 26·74
20	6,358	4·08	15·44
30	6,348	4·10	15·22
80	6,298	4·22	14·03
127	6,251	4·37	12·79
195	6,183	4·50	11·67
256	6,122	4·65	10·86
333	6,045	4·79	9·626
408	5,970	4·97	8·864
491	5,887	5·14	7·722
577	5,801	5·32	6·897
673	5,705	5·53	6·072
760	5,618	5·77	5·326
890	5,488	5·98	4·622
1,017	5,361	6·24	3·957
1,162	5,216	6·50	3·359
1,336	5,042	6·77	2·797
1,449	4,929	6·88	2·530
1,662	4,716	6·85	2·235
2,072	4,306	6·84	1·707
2,458	3,920	6·84	1·288
2,842	3,536	6·85	0·942
3,239	3,139	6·85	0·658
3,675	2,703	6·74	0·435
4,026	2,352	6·84	0·278
4,449	1,929	6·72	0·159
6,378	0,000	unknown	0·000

* Depths down to 20 km. are assumed.

If we assume that the influence of the folds extends down to a depth of 80 km., that from a depth of 20 km. to one of 1449 km., dv/dr is constant and equal to $-0{\cdot}00196$, and that from this depth to the centre of the earth v is constant and equal to 6·83, the ratio of the effect at the surface of the earth of the tidal action on the zones influenced by the folding to the effect of such action on the lower zones down to the centre will be about 55 to 78. If, as is usually supposed, the sedimentary and acid rocks as well as the folding extend to greater depths, the former figure will be increased and the latter diminished. In any case, these figures are sufficient to show that tidal action on the upper zones of the earth must exercise a very considerable influence on the movements of the surface, and that differences of direction of structures in the earth's crust cannot be disregarded in explaining the apparent difference of rigidity which has been observed.

As a matter of fact, we have not at present the materials for a definite conclusion. What is urgently needed is a systematic series of observations in a number of localities differently situated with reference to the more important features of the surface of the earth. JOHN W. EVANS.

The Electrodeless Discharge.

IN the electrodeless ring discharge, the type of spectrum produced depends largely upon the voltage drop per mean free path. This is in general only a few volts, under ordinary operating conditions. A comprehensive survey of the entire subject has been given recently by Mierdel (*Phys. Zeit.* 25, pp. 241-55, 1924). As discussed in this article, spark spectra may be excited by increasing the voltage or by reducing the pressure. Both methods have been employed effectively; the former especially by L. and E. Bloch. We have used the latter method with potassium. At high vapour pressure the arc spectrum alone is observed. When the pressure is reduced, the spark lines appear. Observations on the stages in the excitation of known spectra furnish a trustworthy means for estimating the potential gradient in the electrodeless discharge.

The presence of several differently coloured, concentric rings of discharge has been often noted. The voltage gradient is a maximum at the circumference of the bulb and approaches zero at the centre. This effect is beautifully marked with bulbs 25 cm. or more in diameter, especially with the vapour HCl.

We have operated the electrodeless discharge at extremely low pressures. Mercury at 0·002 mm. and iodine cooled to $-50°$ C. are sufficient for a brilliant and uniform luminosity throughout the bulb. In the spectrum of the latter the line at 2063 A is strongly developed.

On disconnecting one terminal of the ring, a "capacity discharge" fills the entire vacuum system and a uniform glow appears in the bulb. The spectrum of this glow from a molecular vapour is usually almost free from atomic lines.

Because of the low pressures under which the electrodeless discharge may be operated with high intensity, it should rival the low voltage arc for the production of sharp, unreversed lines, and by proper adjustment for low field strength, might be desirable as a source in fine structure analysis. It does not appear, however, to be satisfactory for exciting resonance radiation in mercury.

It was thought that this type of discharge should be especially suitable for the production of the hydrogen Balmer lines. At a pressure of a few thousandths of a millimetre, the probability of two dissociated atoms colliding and recombining is small, so that, once the gas is dissociated, further excitation should give the atomic lines. To our surprise only five or six members of the Balmer series were observed. This is probably due to the fact that collisions of electrons having velocities comparable with the ionisation potential, with hydrogen molecules, usually result in excitation or ionisation without dissociation. Franck has recently given some attention to a theoretical discussion of this phenomenon (cf. "Ergebnisse der Exakten Naturwissenschaften," vol. 2, p. 120, 1923, Julius Springer).

If a liquid air trap is sealed directly to the large bulb, and moist hydrogen is streamed through the system, a rapid "clean up" is observed, so that a considerable amount of hydrogen disappears. On removing the liquid air, a momentary, brilliant red flash occurs. We did not determine whether this is due to condensed monatomic hydrogen or simply water vapour.

When a bulb containing mercury vapour at roo temperature is first operated, before the glass wal have warmed appreciably, a beautiful mercury mirr ring is deposited on the glass, concentric with th metal conducting ring. This is due to the tangenti velocity impressed by the circular field upon th mercury ions formed. Under the conditions of o experiment magnetic forces upon the ions may b neglected. Such a large deposit of mercury occu that possibly the method could be modified for th separation of isotopes.

The ring discharge with a large bulb is an effecti means for producing the activated form of nitrog observed by E. P. Lewis. There can be little doul that active nitrogen consists of N_2 molecules in metastable condition. First, evidence in favour this view was the observation by Fowler and Stru that the spectrum of active nitrogen consists of selection of the positive bands, while L. and E. Bloc as well as Foote, Meggers, and Mohler (Cf. "Origin Spectra," p. 190) found these bands to be excite well below the ionisation potential of the molecul Further evidence may be drawn from Strutt observation that no appreciable current flows betwee sounding electrodes (unless these are in actual conta with the luminous vapour), indicating that glowin active nitrogen is not ionised. The production current when the active nitrogen is in contact wit the electrodes, appears to be a confirmation of th Holst-Oosterhuis hypothesis (*Phil. Mag.* 46, p. 111 1923) that excited molecules upon encountering metal surface may liberate electrons. This phen menon might be useful in fixing superior limits f thermionic work functions or for critical potentials.

Saha and Sur (*Phil. Mag.* 48, p. 421, 1924) ha discussed the data of Lewis, Strutt, and Fowler c the excitation of the spectra of gases and met vapours in contact with active nitrogen, and assumin the observed effects to be due to collisions of th "second kind," have estimated the energy of activ nitrogen to be slightly less than 8·8 volts (incorrect computed as 9·4 volts).

We have found that mercury lines requiring 9 volts for their excitation are strongly developed. does not appear that these may be attributed t molecules or atoms having abnormally high tran lational energy. PAUL D. FOOTE.
ARTHUR E. RUARK.

Bureau of Standards, Washington, D.C.

Pyramid and Prophecy.

IN the notice in NATURE of October 25 of the wor entitled "The Great Pyramid: its Divine Message, by the late Dr. H. Aldersmith and myself, the reviewe by a careful selection of remotely secondary feature of the book, convinces himself he has proved the wor to be of the "assertionist class." He represents tha I have obtained the length of the Pyramid base fro the positions of the sockets, which is not the case. H also represents that I have obtained the Pyramid bas side by adding ten inches to the longest existin socket base side, which is also not the case. Si Flinders Petrie's survey has shown that the cor masonry surfaces are hollowed in up the centre, an that the base casing stones still exist in the centre o each base side. With the casing surfaces hollowed i to the same extent as the core masonry surfaces ar hollowed in to receive them, we obtain the Pyrami base circuit of the same dimension as the ancien Egyptian literature shows it to have been, namely

524 units, the unit being of the value 1·0011 British inches.

The reviewer confuses our historical treatment with our treatment of the fictitious chronology of the Egyptians and our treatment of the Jewish chronological forgeries. These are dealt with as separate considerations in our book. The two latter have been moved successively in every stage of evolution, together with the reasons prompting the various changes. They are not, therefore, brought into operation to show the fiction and forgery at a stage in our historical treatment when, as the reviewer alleges, we had "the records are not convenient." The real fact is that the proofs of the said fictions and forgeries are found to be inconvenient for the historical theory our reviewer has adopted.

It is also alleged that our proof of the fixed calendar year in early Egypt is a matter of assertion. An attempt is made to justify this by a misrepresentation. The reviewer selects what he deems to be an exception to a general rule established in the first chapter of the book, and advances this alleged exception as typical of the application of the general rule. Other authorities have already recognised the importance of the data establishing this general rule—as graphically collected on our Plate IX., as proving the fixed year in Egypt. This element is the real disturbing feature of the book to your reviewer, and while it is a remotely secondary feature of the book itself, it is made almost the entire point of criticism.

The whole range of the reviewer's criticism is entirely covered and satisfied by the graphical analyses of our Plates IX., XVI., and XVII. An unbiassed critic, whether an Egyptologist or not, can really satisfy himself, by the examination of these three plates, as to which statements, the reviewer's or our own, "belong to the assertionist class." I am content to let the whole construction of our work rest upon these three plates as a definite basis, if for no other reason than that your reviewer has summarily dismissed all the other really essential features of the work in the last six lines of his criticism.

I would emphasise, in conclusion, that our work throughout has been based on the very trustworthy archæological and metrological *facts* of Sir Flinders Petrie, but that our co-ordination of these and other related *facts* has compelled us to reject his elaborate Egyptological *theories*. Unfortunately, your reviewer evidently considers a thesis to be "devoted to confusing the public mind" if it fails to accord with the *theories* of the Petrie school of Egyptology.

D. DAVIDSON.

47 Park Square, Leeds,
November 5.

THE review referred to the physical statements, which were suitable because they could be dealt with on ground familiar to the readers of NATURE. They were not "remotely secondary," but are put in the forefront of the volume, in the first 64 pages, and are referred to as a basis for other assertions. The assumed curvature of the casing of the pyramid is contradicted by the mark of the edge of the casing, which is now exposed at the north-east corner; it was straight within an inch. The length of the sides is asserted to have been 9141 inches, and this involves disregarding the sockets, and adding 10 inches to the longest socket side. The intricate assertions about chronology could not be discussed in a year of NATURE; but it is a safe method in all treatment of complex matters to look at the product; if that is physically impossible it is of no effect to argue about the detail. Now the proposed contemporaneousness of the Dynasties XII. and XIII., and the blank left between 1477 and 1216 B.C., are impossibilities in any view held by any scholar familiar with the monuments. Such a sample, of fundamental importance, relieves us from discussing how such results are reached. All that a discussion could prove would be the untrustworthiness of its material or method. There are well-known equations proving that $a=2a$, but they do not convince.

THE REVIEWER.

Spectrum Observations on the Copper Arc.

DURING some work in this laboratory with the copper arc, certain pole effects were observed. The arc was formed by two rods of pure copper, 4 mm. in diameter. The length of the arc was 6 mm. and the current strength 3 amp. on a 220-volt circuit. An image of the arc was projected on to the slit of a Hilger quartz spectrograph (size E.1), the arc being in line with the slit.

Above λ2800, practically no effects were observed, but below this wave-length a number of lines showed a change of intensity between the centre of the arc and the two poles. Lines at the positive pole were more intense than at the negative pole, while a few lines were seen in the positive pole only. Table I. was drawn up according to the notification of Merrill (*Astro. Jour.*, v. 56, p. 475).

TABLE I.

λ.	Group.	λ.	Group.	λ.	Group.
2824·378	1	2276·244	3	2192·236	3
2544·85	5	2263·09	1	2189·599	4
2489·659	4	2246·984	3	2181·68	1
2442·625	1	2242·599	4	2179·37	3
2406·661	1	2230·071	1	2148·93	4
2403·327	5	2228·845	4	2135·92	4
2400·102	3	2227·74	1	2125·978	5
2369·877	3	2218·079	3	2122·916	5
2303·109	2	2210·240	4	2112·023	4
2294·353	4	2199·65	2		

Group (1) slight observable increase, (2) small increase, (3) considerable increase (about twice), (4) great increase, (5) very great increase.

The following lines showed a greater reversal towards the negative pole: 2293·832, 2263·09, 2230·071, 2227·74, 2225·665, 2215·65, 2214·56, 2199·65, 2181·68, 2178·91.

Among the lines found by Shenstone (NATURE, v. 114, p. 501 (No. 2866)) in an 8-volt copper arc, 2293·832 was the only line showing an appreciable change of intensity. The wave-lengths given above are Hasbath's as given in "Handbuch der Spectroscopie" (Kayser and Konen), vol. 7. Basing a Hartmann formula on the lines 2148·93, 2112·023, and 2054·88 (Hasbach's Values), the wave-lengths of the following four lines were interpolated: 2138·49 (Hasbach, 2138·44; Huppers ("Handbuch der Spectroscopie," Kayser and Konen, vol. 7), 2138·54); 2105·03; 2104·70 (Hasbach gives one line at 2104·717); 2079·53 (Pina, *loc. cit.*, 2079·47). The line given by Hasbach at 2085·22 was not found. The dispersion of the instrument in this region is 0·7 mm. per angstrom.

F. SIMEON.
E. S. DREBLOW.

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The Molecular Weight of Glycogen.

RECENTLY Mr. W. K. Slater has prepared glycogen in a high degree of purity, and has commented on the difficulty of obtaining the polysaccharide in an anhydrous form (*J. Physiol.* 58, 163, 1923; *Biochem. J.*, 18, 621, 1924). This observation may be of significance in connexion with the molecular weight of the higher polysaccharides for a reason which I have not hitherto seen discussed, although it is probably familiar to some of your readers.

When the general formula for the complete hydrolysis of a lower polysaccharide, such as *raffinose* or *stachyose*, is considered, it will be seen that the saccharide on being converted into n molecules of hexose requires only $(n-1)$ molecules of water:

$$\underset{\text{Raffinose.}}{C_{18}H_{32}O_{16}} + 2H_2O = 3C_6H_{12}O_6,$$

$$\underset{\text{Stachyose.}}{C_{24}H_{42}O_{21}} + 3H_2O = 4C_6H_{12}O_6.$$

Applying this equation to the hydrolysis of a higher polysaccharide, such as *glycogen*, it would appear either that (1) the higher polysaccharide exists in some stage of the hydrolysis as a cyclic compound requiring the addition of two molecules of water in order to produce two derivative molecules; or that (2) the simple equation for the hydrolysis of a polysaccharide is not quantitatively correct, and instead of being:

$$(C_6H_{10}O_5)_n + nH_2O = nC_6H_{12}O_6$$

it should be:

$$(C_6H_{10}O_5)_n + (n-1)H_2O \rightarrow nC_6H_{12}O_6.$$

Now, if n molecules of hexose be formed from the hydrolysis of one molecule of a polysaccharide by the addition of $(n-1)$ molecules of water, the formula for a polysaccharide must be:

$$(C_6H_{10+2/n}O_{5+1/n})_n$$

and the equation becomes:

$$(C_6H_{10+2/n}O_{5+1/n})_n + (n-1)H_2O = nC_6H_{12}O_6.$$

Consequently, from a percentage analysis of a pure polysaccharide the value of n may be obtained by calculating the difference between the observed value for the hydrogen $(H_{10+2/n})_n$ and the theoretical value $(H_{10})_n$ found from the $(C_6H_{10}O_5)_n$ formula.

WILLIAM FEARON.

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Trinity College, Dublin.

The Uniform Development of Photographic Plates.

IN the issue of NATURE for April 5 we directed attention to the limit of accuracy which is imposed on all methods of photographic photometry, by lack of uniformity in the manufacture, or development of photographic plates. In most cases these errors are much larger than any other errors, and, as the photographic method of photometry is so much used at present, it is very desirable that these errors should be removed.

From various considerations it appears that by no ordinary method of development can fresh developer be supplied to the surface of the plate as fast as the plate can use it, (or, alternatively, the products of development cannot be removed so quickly that they do not remain in appreciable concentration). The result is that any local increase in eddy motion in the developer gives rise to a darker image. If, however, the eddy motion close to the plate could be made so great that fresh developer could be supplied more quickly than it could be used, any small change in turbulence should cause no change in the development.

With this in view, we have tried a developing tank in which the plates are held against the vertical wall and a piston nearly fitting the tank is moved up and down past the plates. Thus the developer is caused to flow at a high velocity through the narrow opening between the piston and the plates. The violent eddies produced effect very thorough mixing.

Developing ordinary commercial plates in this way we have obtained much greater uniformity of density than we can get by any other method, and the results are better than any others published which are known to us, including those obtained with specially prepared plates on flat glass.

G. M. B. DOBSON.
D. N. HARRISON.

Clarendon Laboratory,
Oxford, October 27.

Aquarium Technique.

MAY I claim the hospitality of your columns to publish a method of getting rid of blue-green algae from aquarium cultures for biological teaching? In procuring inoculation material for starting Amœba, Actinosphærium, Rotifer, etc., cultures (see NATURE vol. 102, p. 166; vol. 105, p. 232), blue-green algal spores are frequently included in the "catch." These latter develop quickly, the resulting filaments becoming troublesome inhabitants of the cultures, binding down the other contents and interfering generally with the well-being of the micro-organisms.

I have been experimenting for some time with various chemicals, and have found that ferrous sulphate is an excellent poison for the blue-green algæ, while at the same time it appears to be a "tonic" for the amœba, actinosphærium, and rotifer. In a bad case of infection it was necessary to add 1 gram to a bulk of 2 litres of liquid (June 5). At the time of writing this note, November 1, the rotifer culture so treated is in a flourishing condition.

While awaiting the publication of a paper on *Amœba proteus* (where the subject of hydrogen ion concentration and amœba cultures is dealt with more fully) it may be of interest to the many people who have applied to me for assistance in starting cultures to know that ferrous sulphate has also been used with success for restoring the optimum P_H of the water of an amœba culture that had departed too far from that value for the well-being of the amœbæ.

MONICA TAYLOR.

Notre Dame, Dowanhill,
Glasgow.

British Actiniaria.

I AM preparing a monograph on British Actiniaria which the Council of the Ray Society has undertaken to publish shortly. Certain little-known species of vague systematic position have never reappeared since their first discovery, this usually dating prior to 1860. In such a case it is very desirable that all described forms should be procured before the appearance of a new monograph, so that an accurate species-list and correct details of distribution may be included. If any one who would care to collect living material during 1925 will communicate with me, I shall be glad to supply a list of desiderata and localities, to defray cost of postage, etc.

T. A. STEPHENSON.

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Some Recent Researches on X-Rays: the J-Phenomenon.[1]

By Prof. C. G. BARKLA, F.R.S.

A FEW years ago there appeared to be two, and only two, X-ray phenomena—scattering and fluorescence. One was due to the tremor, the forced vibration, set up in electrons when matter was traversed by X-rays; the other was due to the ejection of electrons from certain atoms and the subsequent free vibration of electrons within those atoms. One was governed by classical laws, the other by quantum laws.

For some years now, what is apparently a third phenomenon has been coming to light. This phenomenon has many of the characteristics of fluorescence (with the emission of characteristic X-rays). As it was found to occur at frequencies higher than those associated with the K-radiations, it was called the J-phenomenon. It has also frequently a close association with scattering, an association which led to what has been called a quantum theory of scattering. The phenomenon is, however, neither X-ray scattering nor X-ray fluorescence, as these terms have been understood; and it seems undesirable to use either term to denote what is quite distinct from both. It is almost certainly governed by quantum laws, and it is possible that its investigation will lead to some solution of the whole problem of the quantum relationships.

THE J-PHENOMENON.

The effects described as the J-phenomenon are briefly these:

As the frequency of an X-radiation gradually increases, though there is in general an increase in the penetrating power of the radiation, under certain conditions the absorption in a given substance exhibits a discontinuity, rising abruptly to a higher level, and afterwards diminishing as previously with increasing frequency of the radiation. This is very similar to the rise in the absorption in a substance accompanying the emission by that substance of a characteristic radiation.

This absorption discontinuity occurs at higher frequencies (higher penetrating powers) the higher the atomic number of the absorbing element. The discontinuities have been observed in carbon, nitrogen, oxygen, aluminium, sulphur, copper, gold, and platinum.

The sudden increase in the absorption of the rays is accompanied, when the absorbing substance is in the gaseous state, by a sudden increase in ionisation in that substance. When in the solid state, the absorbing substance emits an additional corpuscular radiation. The ejected electrons are apparently slowly moving electrons.

All these phenomena are suggestive of the emission of characteristic radiations of another series, the J series.

There are, however, a number of characteristics which distinguish the J-phenomenon very clearly from the phenomena associated with the emission of characteristic radiation of the now well-known K, L, M series. These may be briefly summarised:

1. The phenomenon is conditional on some unidentified factor or factors (possibly of intensity or superposition), whereas the only condition essential to X-ray fluorescence as previously known is that expressed by Stokes's fluorescence law.

2. The sudden changes in absorption and in ionisation appear to be absolutely abrupt, even when a *heterogeneous* primary beam is used.

3. The point at which the discontinuity occurs appears to be more closely connected with the rate of absorption of energy than with a critical wave-length (though the former, of course, depends upon wave-length).

4. The series of critical wave-lengths in the various elements cuts right across the well-known K series.

5. The change of critical frequency with atomic number is very small.

EXPERIMENTAL EVIDENCE.

The experimental facts illustrating 3 (above) are so remarkable and so entirely new, that they are worthy of description even in a short summary.

(*a*) Two beams proceeding from the same X-ray tube at the same time in different directions may have different penetrating powers. (There are various possible reasons for this; though it may be suggested that the obvious ones are not necessarily correct.) As the tube hardens up, the discontinuity in the absorption of each beam occurs, not when a particular state of the tube is reached, but when each beam, independently of the other, reaches the critical penetrating power for the substance used as the absorber.

(*b*) A heterogeneous beam direct from an X-ray tube in some cases shows no absorption discontinuity as the tube becomes harder, whereas when the same radiation is filtered and so brought to a higher average penetrating power, the discontinuity in absorption occurs at the correct critical penetrating power for the absorbing substance used. Thus the absorption of a complex beam is not the sum of the absorption of its constituents.

(*c*) Again, in some experiments, if the radiation is passed through a thin filter, as the tube hardens the absorption discontinuity does not appear; whereas when a thicker filter is used, the absorption of the transmitted radiation shows a well-marked discontinuity, and at the correct critical penetrating power.

(*d*) Further, and confirming the above, in some experiments the absorption discontinuity does not appear when *thin* absorbing sheets (absorbing only a small fraction of the radiation) are used; whereas the discontinuity appears when the absorption is measured by means of *thick* absorbing sheets.

(*e*) Transmission of a given heterogeneous radiation through successive very thin sheets of absorbing material, shows (as might be expected from the above results) that at a certain critical thickness there is an abrupt drop in the intensity of the transmitted beam; that is, the exponential law of absorption evidently breaks down and there is a sudden extinction of the primary beam. After this the absorption differs little, if at all, from what is normally expected. Whether or not the transmitted beam is truly transformed is not shown by these experiments; in experiments of another kind, however, when the sudden extinction occurs, the transmitted beam is definitely of a more absorbable type than previous to the abrupt change.

These results naturally suggest such inquiries as the

[1] A summary of the Silvanus Thompson lecture delivered before the Röntgen Society on April 1.

following: Are we really measuring the intensity of the radiation? Is a certain portion of the ionisation (used as a measure of intensity) produced by a method distinct from the remainder, and are all the phenomena above described due to this special ionisation? Is a fraction of the observed effect of the X-rays due to the combined action of a number of radiations differing in wave-length? Is a certain portion of the ionisation due to short-range electrons as distinct from the bulk of the ionisation taken as a measure of intensity?

An answer to these and many other questions is given by the results of experiments in which various methods of measuring intensity were adopted. Ionisation in air, in sulphur dioxide, and in hydrogen produced by the emission of high-speed electrons from an aluminium plate in the path of the X-rays, and ionisation produced by the high-speed electrons ejected from copper, were all used as measures of intensity. The discontinuity was observed by each method, and at the same critical penetrating power. The phenomenon thus appears to be independent of the particular method of measuring the X-radiation. We must therefore assume that the phenomenon is one in the X-rays themselves, for our only measure of X-rays is obtained from such effects.

These phenomena have been observed with radiations from many different tubes and with different anticathodes; with strong and with very feeble radiations; with narrow pencils and with wide beams; with polarised and with unpolarised radiations; with heterogeneous and approximately homogeneous radiations; with primary radiations, scattered radiations, and characteristic radiations.

Applications to the Scattering of X-Rays.

The results recorded above have many important applications, notably to the phenomenon of scattering of X-rays.

Röntgen radiation which is scattered from light elements is exactly like the primary radiation in its penetrating power (and hence its wave-length) over a long range of wave-lengths. The polarisation, distribution, and intensity of this radiation are all accounted for by the classical theory of radiation. There is no shadow of the quantum in the phenomenon. The appearance under certain conditions of a secondary radiation differing from the primary indicated the probability of the emission of a fluorescent radiation of the J series by these light elements. Compton has recently called this transformed radiation "scattered radiation." It appears that this transformed radiation is neither a fluorescent radiation nor a scattered radiation, as these terms have been understood.

The transformation observed by us is the transformation associated with what is described above as the J-phenomenon. For some reason (possibly connected with intensity), the scattered radiation appears more susceptible to the J-phenomenon than the primary radiation. The following brief statement of results obtained from experiments on scattering show that the true phenomenon of scattering may be completely masked by the J-phenomenon as described above; the results are precisely those to be expected from the application to the scattered radiation of the laws governing the J-phenomenon. They are all contrary to Compton's hypothesis. (Most of the following results were obtained in collaboration with Dr. S. [illegible] Khastgir.)

1. As the wave-length of a primary radiation diminishes, the scattered radiation remains exactly like the primary (measured by its absorbability) over a long range of wave-lengths. There is nothing even approaching the difference between primary and scattered required by Compton's hypothesis.

2. An apparent change—a difference between scattered and primary radiation—appears quite abruptly as the frequency of the radiation is increased. It is a change of the order of five or more times the error of experiment. There is no mistaking it. This well-marked difference in penetrating powers of scattered and primary radiations persists for all shorter wave-lengths. (This phenomenon seemed at first to confirm the indications of an emission of characteristic rays of the J series.)

3. Further sudden changes in the scattered radiation appear as the wave-length of the primary radiation is diminished, the difference between the secondary and primary radiations becoming greater at certain critical, though not accurately definable, wave-lengths. There are several well-marked discontinuities.

4. Using various substances to measure the absorbability of the primary and secondary radiations, the above-mentioned discontinuities occur not at the same but at slightly different wave-lengths.

5. When *thick* absorbing sheets are substituted for *thin* ones to test the character of the radiations, the discontinuity—the sudden appearance of or increase in the difference between the primary and the secondary radiations—appears earlier; that is, when the primary is of greater wave-length than is the case when thin absorbing sheets are used.

6. The wave-length at which the difference appears (the discontinuity) depends to a certain extent both upon the *material* and upon the *thickness* of the radiating substance.

7.[2] In certain selected cases, we can identify the thin layer of absorbing material in which the change occurs. Thus as primary and secondary radiations are transmitted through an increasing thickness of absorbing material, the absorptions up to a certain thickness are exactly alike (unmodified scattering). A further thin layer makes all the difference between the two. Afterwards the scattered radiation is the more absorbable. Thus we have curves showing quite definitely that an unmodified scattered radiation becomes suddenly modified by transmission through material quite outside the scattering substance. It is, of course, only by proper selection of the radiation experimented upon that this transformation can be located in this way. But this fact alone shows that the transformation is not necessarily or essentially in the process of scattering.

The importance of this result is little affected by the fact that in numbers of experiments in the Laboratory at Edinburgh as elsewhere, long series of observations show a persistent difference between primary and secondary radiations without a suggestion of equality of wave-length or of the abrupt changes referred to above.

[2] Results under section 7 were obtained in April 1924, shortly after the lecture before the Röntgen Society.

ne experiments only *appear* to indicate a change of ave-length produced by scattering. It is possible that, these cases, the J transformation occurs at the birth the scattered radiation. But facts of much greater gnificance are these :

As the frequency of the X-radiation increases we can, many cases, observe the quite abrupt transition from unmodified scattered radiation to the modified attered radiation. There is a gulf between the two hich makes the identification unmistakable and shows at some special condition is essential to the produc- on of the modified scattered radiation. We can, in lected cases, take the unmodified scattered radiation d transform it into the modified scattered radiation, en identifying the thin sheet of absorbing material hich affects the transformation—quite outside the attering substance.

These are not isolated results, nor are they of the zy, indefinite kind which some seem to suspect. The anges are of a magnitude several times the magnitude the possible error. The phenomenon has all the aracteristics of the J-phenomenon as observed iginally in primary radiations, and as briefly indicated ove.

It is not intended here to discuss either the process even the nature of the transformation involved, for ough many experiments have been made, many more e necessary before we can get a secure foundation for y theory. The phenomenon is not scattering nor it fluorescence with the emission of characteristic diation as generally understood ; it is a new—a ird X-ray phenomenon. Without committing one- lf to an opinion, it may be stated that there is the pearance of a sudden absorption of the beam followed y a re-emission of radiation of somewhat greater ave-length proceeding in the original direction of opagation. Absorption laws break down ; methods comparing intensities of radiation are no longer pplicable. This needs to be borne in mind in experi- ents upon penetrating radiations. It seems highly obable, for example, that in experiments on the sorption of penetrating X-rays and γ-rays, the trans- itted beams produce far too much ionisation for their nergy, and thus appear not to be absorbed so strongly s they really are. For we have observed sudden increases of ionisation of so much as 100 per cent. due to a very slight diminution in wave-length. Thus there seems little doubt that when penetrating X- and γ-rays are transmitted through thick layers of absorbing material, the ionisation coefficient is suddenly increased at certain points (under certain conditions the change may be gradual), and the transmitted radiation then produces a greater effect than is accounted for by intensity alone. It appears more penetrating than it really is.

Conclusions.

The broad conclusions are that under certain conditions not yet identified, but apparently depending on the rate of energy absorption, discontinuities occur in the absorption of X-radiation accompanied by corpuscular emission from the absorbing substance and ionisation when that substance is in the gaseous state. The transmitted primary radiation behaves as a transformed radiation.

No direct evidence of the emission by the absorbing substance of a characteristic X-radiation (of J series) has been obtained. If it exists it must be very feeble. What originally appeared to be a fluorescent radiation (and to others a modified scattered radiation) has been found in some cases to be merely the scattered radiation transformed by transmission through matter after its production. The radiation when observed is neither characteristic nor scattered, but is the scattered radiation after having been transformed by the J process (a process similar in many ways to fluorescence with the emission of characteristic X-rays). The necessity for critical conditions suggests obedience to the quantum laws in some form. The well-known laws of X-ray absorption break down when the critical conditions are reached.

Though it is realised that some of the results here recorded will possibly need re-statement or modification when they are tested by experiments extending over a wider range of conditions, the results already obtained are so absolutely new, so remarkable, that they seem to justify publication before a solution of the whole problem has been found. Further investigation of the subject promises to lead to some of the most interesting and important generalisations.

Historical Tradition and Oriental Research.[1]

By Prof. J. H. Breasted, University of Chicago.

It has often been remarked that the outstanding trait of the untrained mind is credulity. The rationalisation of man's views of the world has been a very slow rocess and it is still very far from a completed process. t has commonly been thought to have begun with the reeks, but its origin must be sought in the Orient in a eriod long before Greek civilisation had arisen. The dwin Smith Medical Papyrus, acquired in 1906 by the ew York Historical Society, discloses the inductive rocess of scientific investigation already in operation n the seventeenth century before Christ. For example, his document contains the earliest occurrence of the ord " brain " anywhere appearing in surviving records f the past. The word is unknown in Old Testament Hebrew, in Babylonian, Assyrian, or any of the ancient languages of Western Asia. The organ itself therefore was evidently discovered, and the recognition of its various functions was begun, for the first time by these physicians of early Egypt in the thousand years preceding the seventeenth century B.C. The observations recorded in the Edwin Smith Medical Papyrus show that its author had already observed that control of the members and limbs of the body was localised in different sides of the brain ; and the recognition of localisation of functions in the brain, mostly the work of modern surgeons and others within the past generation or two, had already begun in the seventeenth century B.C., at a time when all Europe still lay in savagery or barbarism.

There is in existence part of an original transit

[1] From a paper communicated to the National Academy of Sciences, Washington, on April 29, and published in the Proceedings of the Academy or July, vol. x. No. 7, 1924.

instrument, made, as stated by the inscription upon it, by no less a king than Tutenkhamon, in the fourteenth century B.C. It did not come from the tomb of Tutenkhamon, but was apparently made by him for the tomb of his (or his wife's) great-grandfather, Thutmose IV. (fifteenth century B.C.). This and another such piece at Berlin are the oldest scientific instruments of any kind now known to us. It was used for determining meridian time, especially at night, in order that the observer might then set his water-clock, with its 24-hour divisions, a division of the day which thence passed over into Europe in Hellenistic times, whence it was transmitted to us.

Now Herodotus reports a tradition current in his day (fifth century B.C.), that the Greeks were greatly indebted to Egyptian knowledge. This tradition has in recent times been universally rejected ; but it would seem that there was much truth in the tradition transmitted to us by Herodotus, and that its complete rejection by classical prejudice is unjustifiable.

The fact that the early Egyptian scientific worker employed an inductive method so far back as the seventeenth century B.C. does not, however, mean that he had completely banished from his mind all belief in magic or in supernatural forces. This truth has been well demonstrated for later ages by Prof. Lynn Thorndyke in his monumental volumes on "The History of Magic and Experimental Science." Undoubtedly the Greek took the longest step in freeing his mind from inherited religious and traditional prepossessions. Using astronomical observations undoubtedly drawn from Babylonia, Thales predicted a solar eclipse in 585 B.C. Astonishing as it seemed to the Greeks, there is little probability that this feat was an unprecedented achievement. What *was* unprecedented, however, was the revolutionary generalisation which Thales based upon his ability to make such a prediction. For he banished the erratic whims of the gods from the skies and discerned the sway of natural law throughout the celestial world. To tear away and fearlessly to trample under foot beliefs and superstitions which had been sanctified by age-long religious veneration demanded dauntless loyalty to his own intelligence. This first supreme enthronement of the human mind was probably the greatest achievement in the career of man.

We can pay no greater tribute to such Greek thinkers than to recognise, that although they put credulity to rout, they could not banish it altogether. It has survived with extraordinary persistence even to the present day. In modern times it was of course the tremendous significance of the discoveries of Galileo which most impressively reproclaimed the supremacy of natural law and the sovereignty of the human mind in discerning that law.

From Galileo's struggle with the church to Huxley's debate with Gladstone, the heavy guns of natural science have dealt tradition one destructive blow after another. It has been under this destructive attack at the hands of natural science that historical criticism has grown up in modern times since Niebuhr. Indeed it has been no accident that in the United States the first serious discussion of the Old Testament narratives in Genesis and Exodus was written by Thomas Cooper, who was the associate of Priestley in the discovery of oxygen. Cooper was Thomas Jefferson's appoint as first president of the new University of Virgini but in the Virginia of that period the social feeli against Cooper for having assailed the literalistic int pretation of the Old Testament was so strong th Jefferson was unable to secure his induction into offic Jefferson's influence, however, secured Cooper's appoin ment as president of the University of South Carolin where public opinion was at first not so strong again him as in Virginia. It is interesting to note that befo the end of the 'twenties, that is, less than a century ag conservative sentiment was strong enough to bri about Cooper's dismissal from the University, althou his personal popularity was such that he was prompt appointed to codify the laws of the State, and the fir legal code of the State of South Carolina was edit by this gifted representative of natural science a historical criticism.

The merciless critical scalpel which had not spar Hebrew tradition was equally unsparing in its treatme of the cherished classical heritage from Greece ar Rome. The tales of Romulus and Remus, the Troja war, and the entire cycle of legends which were link with it, were shorn away. A critical attitude of un versal negation arose. It included the whole Medite ranean and Oriental world : Rome, Greece, Hebrew Babylonians, Assyrians, and Egyptians. Historic criticism would not allow that early man at th beginning of the age of writing had ever heard a transmitted an echo from earlier ages, which, becau they possessed no writing, could only send on the story in the form of oral traditions. This attitude the historical critic may be compared with that of a observer who stands on a mountain peak, and, lookir off across a distant landscape to a dim horizon shroud in mists and cloud, insists that the intermittent glimps of mountain profiles which vaguely emerge on th far-away skyline cannot correspond to any reality. short, without ever having been himself on the grour to investigate, he denies the existence of the phanto mountains on the horizon.

The orientalist, if he be something more than philologist, may be compared with the explorer wh pushes out to that distant horizon, and is able t determine on the ground whether the phanto mountains really exist. Such investigation is, howeve relatively recent, and the historical critic could scarcel anticipate that it was coming. He seemed to be qui safe in sweeping away all early human tradition. dealt with a world of gods, demi-gods, and heroes ; was dominated by the whims and caprices of angr or jealous divinities, and it was filled with impossib wonders and prodigies. How could a soundly critic historian accept narratives which seemed so manifestl impossible ? We must grant that in the circumstanc rejection complete and unqualified seemed the onl safe course.

Such critical negation was supreme when, fifty yea ago, archæology began to reveal with startling vividnes the facts and the daily equipment of human life in th very ages with which the rejected traditions deal In the seventies of last century the excavations of a untrained observer from the outside disclosed a astonishing vision of pre-Greek civilisation at Tiryns Mycenæ, and Troy. The incredulity with which thes

iscoveries of Heinrich Schliemann were greeted by the assicists was highly characteristic. His excavations covered and exhibited to the incredulous eyes of the estructive critics the whole material equipment of aily life from the very age of the Trojan war (or wars), nd from the very city in and around which it was aged.

Similar revelations, involving far earlier periods of me, rapidly disclosed the successive stages of the uman career from a remote antiquity, reaching well ack of the beginnings of the world as dated by an lleged "Biblical" chronology. In dealing with the raditions of these earlier ages the orientalists soon eveloped a similar school of negative criticism. Such raditional accounts were promptly thrown into the iscard. Maspero's bulky history of the oriental eoples, still a standard work on most modern library helves, tells us that Menes, the first king of the First Dynasty of Egypt, was a purely mythical or legendary igure. Nevertheless we now possess his tomb, and in ur collections at the University of Chicago we have a iece of his personal ornaments, a gold bar bearing his ame in hieroglyphic — the oldest piece of inscribed ewelry in existence. Since 1894, thousands of pre-istoric graves have been excavated along the margin f the Nile Valley, revealing to us the successive stages f human advance for many centuries before the once egendary Menes.

Much the same process is going on in the investiga-ion of Babylonian history. Even the mythical hero Gilgamesh, the original of the European Hercules, bids air to emerge at last as a remote city king of early Babylonia, who gained a reputation for his prowess in war, until he became the typical and proverbial strong man of all ages.

The crowning disclosure in this unprecedented series of unexpected revelations has recently come from Asia Minor. Nearly twenty years ago the German Assyri-ologist, Hugo Winckler, visited the mounds of Boghaz (or Boghaz Köi—"Boghaz village") in central Asia Minor. As he walked over the ruins he kicked up with his boot heel several cuneiform tablets, lying practically on the surface. Below were piled the clay tablet archives of the Hittite "Foreign Office," the earliest of which had been lying there at the capital of the Hittite Empire since the middle of the second thousand years before Christ. The result has been the decipherment of ancient Hittite, or rather a whole group of Hittite, dialects. The War has intervened, and since Winckler's death the progress of examining this enormous body of archives has unavoidably been very slow. We owe a great debt, especially to Hrozny and Forrer, for the invaluable disclosures which they have wrung from these documents.

One of these tablets reports a war of Atreus, king of Achaia, against the king of Caria at about the middle of the thirteenth century, that is, about 1250 B.C. There can be no doubt that in this tablet we have a contemporary reference to the cycle of Trojan wars—a reference which must be regarded as an irreproachable historical source, as old as the events which it records. Thus out of the lost oriental background of Greek history in Asia Minor comes a *written* document confirming a Greek tradition, born in an age when the Greeks themselves still lacked writing. Because writing reaches further back in the Orient by nearly three thousand years than it does in Greece, we are able to confirm Greek tradition out of contemporary written sources.

It has long been recognised that in the early development of Greek civilisation the cities of Asia Minor took the lead. Thales, who lived in one of these cities, was an example of this early stage of Greek culture in Asia Minor. It is also evident that the inland background of oriental culture contributed much to this early development of Greek civilisation on the western fringes of Asia. It is out of this newly recovered oriental background that we are slowly regaining the earlier forerunners of Greek civilisation.

This contemporary reference to the Trojan war is an epoch-making revelation, which must react powerfully upon our treatment of early human traditions. It at once demonstrates that such traditions must not be thrown to the scrap-heap, but rather carefully divested of gods and goddesses, prodigies and wonders, and then examined for the nucleus of sober fact upon which the legendary tale has been built up.

As we look back upon our earliest historical horizon, we now know that the men who stood there in the grey dawn of the age of writing were able to hear echoes of a remoter past, transmitted in the form of oral tradition, of which some portion was then committed to writing and thus survived. In our modern effort to recover and reconstruct the story of man's past career, we have thus rehabilitated a new body of sources, however cautious it behoves us to be in making use of them. Not credulity alone, but also historical method, demands that we recognise these traditions, or the nucleus of fact to be drawn from them, as a body of sources to be restored to their proper chronological position in the succession of surviving evidences which reveal to us the past career of man on earth.

We are the first generation of men able to survey that career without a serious break. As we marshal the evidence for its successive stages, the humanists stand shoulder to shoulder with the workers in natural science, for as we look backward it is the materials and the methods of the geologist which confront us first. The geologist is succeeded by the palæontologist, the anthropologist, the anthropogeographer, and the archæologist. It is at this point, on the border land between the investigations of the worker in natural science and those of the humanist, that we must insert these long-discarded echoes from an age able to transmit only oral tradition, the true value of which oriental research has now interpreted to us. The Homeric songs of the Trojan war can no longer be regarded as exclusively noble literature, of purely legendary content; and, in the presence of these earliest surviving monuments of science, the Greek tradition of substantial Egyptian contributions to knowledge must not be rejected as baseless. There is every possibility that the tombs of Egypt may yield us further scientific treatises like this great Edwin Smith Medical Papyrus, and we cherish the hope that the thirty-five or forty chests, boxes, and caskets still lying in the innermost chamber of the tomb of Tutenkhamon with their seals unbroken may contain written documents.

Rotor Ships.

DURING the last few days, accounts of a new departure in ship propulsion have reached Great Britain. One vessel has been modified to illustrate the working of the new method and has operated in Kiel Harbour. The new invention represents an application of scientific principles known for many years; an early English paper entitled "The irregular flight of a tennis ball" was published in 1878 by Lord Rayleigh, using the same principle in explanation. The practical deduction from the general physical and mathematical idea is that a body like a circular cylinder, spinning about its axis and moving at right angles to it experiences a force which is at right angles both to the axis of the cylinder and to the direction of translation. The force is proportional to the product of the speeds of rotation and translation.

Herr Anton Flettner, the inventor of the "Rotor ship," uses two masts, one forward and the other aft, as pivots for two rotating drums. The drums are about 60 ft. high and 10 ft. in diameter, and are driven at 100 r.p.m. by electric motors of 9 h.p. The direction of rotation may be reversed and with it the resulting force. To see the method of application to steering, imagine the ship to be moving forward under power from auxiliary machinery with the two towers rotating in opposite directions. The forces will be athwart the ship in opposite directions and will together give a couple turning the ship. The only effect of rotation in the same direction would be to produce drift.

The most important of the claims made for the invention appears to be its capacity for extracting energy from the wind. Clearly, from what has been said above, the maximum propulsive effect from th circulation will be obtained with the wind across th ship, and it will fall off as the wind comes into th direction of motion. By changing the direction rotation of the towers and tacking, advantage can b taken of any wind, and, in a general way, the problem are of the same character as those connected wit sailing.

There are points of difference, however, which ca only be dealt with adequately on the basis of efficienc and the data so far received are insufficient for a dis cussion. Circular cylinders produce vigorous eddies i their wake, and such experiments as have been mad show that the circulation produced by rotation i imperfect; the result is a very much smaller forc across the direction of translation than is calculated and in addition there is a drag.

It is probably not generally realised that the win of an aeroplane, without rotating, is an efficient mean of producing circulation, and that the support of a aeroplane is an example of the law enunciated at th beginning of this note. The sail of a ship belongs t the same category, and from the fact that the experi mental work on circulation was executed at the Aero dynamical Laboratory at Göttingen, where this is ver well known, and that no aeronautical applications hav been made, it appears that scepticism as to the claim for high efficiency of the "rotors" is justified. Th accounts received are such that it is difficult to dis entangle achievements and hopes, but the claims fo handiness and seaworthiness, etc., may merit close attention when fuller details are to hand. L. B.

Obituary.

Sir Archibald Geikie, O.M., K.C.B., F.R.S.

THE "Long Life's Work" reviewed in NATURE of July 26 has been brought to a close. Sir Archibald Geikie passed away in his eighty-ninth year on November 10. For several years gradually failing health had confined him to the home he had made at Haslemere, but his pen was busy almost to the last, for the autobiography referred to bears the date 1924. The details of his upbringing and career, his extensive travels, the innumerable functions in which he was a leading figure, and the many friendships he made, are set out in the review in NATURE and need not be repeated, but his relation of personal experiences may now be supplemented by an account of geological achievements, which he passes over lightly. The comparative share which he and his contemporaries took in the elucidation of some of the great problems of the day requires a fuller consideration than could be given in a volume which was designed as a record of reminiscences rather than as a geological treatise.

Geikie was for many years the leading figure in British geology. His numerous original contributions to scientific journals, the charm and lucidity of his style, and not least the lasting value of his "Text-book of Geology," placed him in the forefront of living geologists. His work, unlike that of Lyell, was largely founded on the observations which he himself had made in the field, either original work for which he was alone responsible, or the work of colleagues which he had inspected in his official capacity on the Geological Survey. In either case his eye for scenery, his rapid grasp of essentials, and his facile and ever-industrious pen enabled him to record some of the greatest advances made in geology during the present era in papers which are unsurpassed for interest, elegance of diction, and lucidity.

When the Murchison Medal of the Geological Society was presented to Geikie forty-three years ago, special mention was made, in an already long list of valuable papers, to his work on the Chronology of the Trap Rocks of Scotland. He had been struck by the remarkable abundance of traces of volcanic action in past geological times as an outstanding feature in the geology of Midlothian and West Lothian. He recognised distinct vents from which lava had flowed on to the surface, or from which dust had been shot into the air, all to be buried and intercalated later on in the sediments of the Old Red Sandstone or Carboniferous formations. From this time on he tells us "the wide subject of volcanism . . . grew to hold the dominant place in my geological enquiries, leading me ultimately to pursue it far and wide over the whole of Scotland, and into every tract in England, Wales and Ireland where relics of volcanic history have been preserved. The study further impelled me in later years to visit the volcanic regions of Auvergne, the Eiffel and Italy,

ıd eventually to explore the great lava-fields of Western America" ("A Long Life's Work," p. 62). is exhaustive study of the subject found issue in a aper communicated to the Royal Society and afterards in "The Ancient Volcanoes in Great Britain," ne of those books in which he fascinates non-geological aders as well as experts by descriptions of some of the ast episodes of the earth's history, written in his own imitable style.

The controversy on the North-West Highlands is riefly referred to in the autobiography mentioned bove, but cannot be passed over so lightly in estimating eikie's share in the advance of geology. He accomanied Murchison in 1860 on a tour through the ighlands. Cambrian [1] fossils had been recognised by harles Peach in 1854 in the limestones of northestern Sutherland, and Murchison wished to extend is conclusions drawn from that discovery to the entral and southern Highlands. "I have to admit," eikie writes in 1924, "that this expedition . . . was premature attempt to solve problems which have not et been all solved . . . the true structure of the lighlands was far too complicated to be unravelled y desultory and hasty traverses of the ground. It equired to be patiently worked out by detailed mapping, uch as has revealed the complicated grouping of the ocks in Sutherland" ("A Long Life's Work," pp. 4, 85).

The Sutherland complications here referred to had eceived Murchison. The one infallible test of the elative age of geological formations is that of superosition, provided always, and this is a big proviso, that he superposition is original and not the result of the eshuffling of the formations by subsequent earthnovements. Here lay the trap in Sutherland, for trata containing Cambrian fossils were seen, not once ut repeatedly, to be directly overlain by crystalline chists, the "Upper Gneiss," as it was called in contraistinction to the Laurentian gneiss which forms the oundation of the whole region. No one making mere raverses of the area could doubt the evidence of his yes, and it was only seventy or eighty years after the irst account by Macculloch and after repeated visits y many eminent geologists that the truth was learnt. Nicol, who had accompanied Murchison in one of his isits, strongly opposed his views in 1856. He stablished the pre-Cambrian age of the Torridon Sandtone, which was regarded by Murchison as Old Red Sandstone by reason of a remarkably close lithological esemblance, and in 1858, at a meeting of the British Association, he stated his conclusion that the "Upper Gneiss" owed its position to faults. Heddle, while ıccepting much of Murchison's sequence, thought that he Cambrian strata had been dropped in by faults, and Callaway also declined to accept the natural superosition of the "Upper Gneiss" upon them. Much lepended upon the correctness of these views. The 'Upper Gneiss" extends over large areas in the central Highlands, and if Murchison had been right, all the ocks must have been regarded as of post-Cambrian ıge. Moreover, it would have been necessary to suppose that a great series of rocks had been highly metamorphosed, while the strata below them remained unaltered, with their fossils not obliterated. Space does not permit of an account of all the contributions to the controversy,[2] and I must come at once to the solution. Lapworth, in speaking of the apparent superposition, used the words "it would appear, at first sight, that his [Murchison's] theory of the sequence, so far as the Durness area is concerned, is "absolutely impregnable," but in the Erriboll region he obtained definite proof that the Cambrian beds are newer than the "Upper Gneiss." By exhaustive, systematic examination of the whole Durness-Erriboll region he determined the true sequence, and established the fact that the superposition of the "Upper Gneiss" is actually due to subsequent earth-movement on a great scale.

Geikie, who had adopted the views of his chief, when once it was brought home to him that they were erroneous, was largely instrumental in their correction. He put in hand the detailed six-inch surveying of the debated areas, and selected Peach and Horne for the work, instructing them, perhaps needlessly, "to get at the truth, regardless of anything that had been published on the subject" ("A Long Life's Work," p. 214). He himself inspected their work, under stress of mist, rain, and gale, in order to convince himself of the correctness of their interpretation. The maps of the Durness-Erriboll region confirmed Lapworth's work. They were completed in 1884, and thereupon the North-West Highlands became classic ground to geologists all the world over, not only as exhibiting overthrusting on a scale hitherto unknown in the British Isles, but also for the skill and detail of the mapping by which these structures had been recorded.

Previously to this, Lapworth had, by brilliant palæontological work, thrown a flood of light on the sequence of Lower Palæozoic rocks in the southern uplands. The sequence at Moffat, as accepted by Geikie and others, involved the assigning of abnormal thicknesses and characters to certain formations. By intensive study of the fossils, Lapworth showed that the abnormalities were due to frequent repetitions of the same strata by excessive plication. In the Girvan region also profound dislocations, folds, and inversions had obscured the original order. The succession, as Lapworth found it at the hands of his predecessors, consisted of an enigmatical group of great thickness, varying extraordinarily in petrological character and containing an admixture of fossils elsewhere characteristic of distinct formations. He left it an orderly sequence, each member of which was distinct and constant in petrological character and fossil contents over the whole area.

The share taken by each of the protagonists in this controversy now lies open to posterity for judgment. That Geikie added much to the solution of these great Scottish problems can be affirmed with confidence, but he had not been able, either himself or through others, to make those exhaustive examinations in the field of the structures and the fossils that were essential for the unravelling of the tangles. Possibly the fascination of exercising his power with the pen led him to expressions of opinion earlier than his better judgment might have counselled. He was influenced also, without doubt, by a feeling of loyalty to his chief, as well as by

[1] I use the name Cambrian here to avoid confusion. The rocks were not hen so called.

[2] A full history of the investigation will be found in "The Geological Structure of the North-West Highlands of Scotland" (Memoir of the Geological Survey), 1907, chap. ii.

a natural disinclination to abandon views to which he had committed himself in print. Our sympathies may well go out to a man who puts up a good fight for his own work, for it means that he has had his heart in it and believes in it. I am reminded of an anecdote about Ramsay (Geikie's predecessor in office), who by a rare mistake had shown upon his map of North Wales as a lava a rock that was obviously a volcanic ash. Years after, brought face to face with the rock in the field, he opened a discussion with the remark, "Whatever else is wrong, my map cannot be." True it is that in the memoir already mentioned (*v.* footnote 2), which was edited by Geikie, full justice has been done to all who took part in the controversy. It is true also that, in a preface to the original report by Peach and Horne, Geikie confessed that he had been wrong. Yet one could have wished that in his last book, in which, near the close of his life, he relates his own personal experiences, and from which posterity will judge what manner of man he was, he had taken the opportunity of expressing some more generous appreciation of the labours of his fellow-workers.

I have spoken plainly, I hope not too plainly, of the part taken by Geikie in controversies, but there remains the great mass of his original unchallenged work, which for many years to come will keep his memory fresh as one of the greatest of geologists. Outstanding among his original researches are those upon volcanic phenomena, to which reference has already been made, but his papers on the Old Red Sandstone and on the glacial phenomena of Scotland are also classics. He was the first to give a connected account of the glacial deposits of his native country, and to advocate, in advance of the general opinion of his time, the agency of land-ice as a distributor of drift. In South Wales he utilised his experience of Lower Palæozoic and Archean rocks in correcting some generalisations by Dr. Hicks, himself a pioneer in that branch of geology, but prone to impetuous solution of difficulties by calling in many a *Deus ex machina* in the shape of faults. But I venture to think that he derived almost more pleasure from the writing of biographies of men he had known and worked with, and whose characters he could portray in his own kindly way. These books not only appeal to the non-geological reader, but also provoke the expert to explore literature he might have overlooked. Geikie himself was indefatigable in delving into the earliest records of geology. The "Founders of Geology" and "The Love of Nature among the Romans," to mention but two, could only have been written by a man who had read deeply in modern and ancient literature and had remembered wisely. In his "Reminiscences," his "Sketches," and his "A Long Life's Work" his pen was not fettered by the constant endeavour to avoid the use of technical expressions, and his easy, graceful language testifies to the value of his early training in the humanities and of his appreciative reading of good authors. With his keen sense of humour he could never be dull.

As a companion he was interesting and delightful, full of experiences, and charged with racy anecdotes which could be readily drawn from him, but were never forced on an unwilling listener. During his travels he made friends everywhere and he never lost their affection. In all parts of the world where geology is known, his loss will be felt as a personal bereavement.

The career now ended has indeed been a remarkab one. Adopting geology as his life's work, witho interest and rather to the consternation of his fath he rose by his own exertions to the highest scientif posts Great Britain can offer, and received honours i numerable at home and abroad. Untiring industr directed by great sagacity was the keynote of his succes

A. STRAHAN.

MR. HARRY INNES PERKINS, I.S.O., died at Sydne on October 24, at sixty-three years of age, havin retired in 1919 after a long and useful career in th Colonial Service. The son of Major-General E. N Perkins, he was born at Simla, and educated at th King's School, Rochester. He held for a short tim a post as Clerk to the Director of Public Works i Trinidad, and at the age of twenty obtained an appoint ment on the survey staff in British Guiana, where h ultimately became Acting Crown Surveyor. In 1884 1885 he took part in an expedition to Mount Roraima and prepared a map of the mountain for the Roya Geographical Society. In 1895 he was appointe Acting Commissioner of Mines. Early in that yea his "Notes on British Guiana and its Gold Industry was published. In these notes, Perkins prophesie that valuable diamond deposits would one day b discovered in the Mazaruni, which has since becom an important diamond-producing area. While Act ing Commissioner of Mines, he served as one of th British Commissioners appointed for the demarcatio of the British boundary between British Guiana an Venezuela, and in 1901 wrote a report on the geologica features of the district traversed by the Commission In some of his geological work he was associated wit Sir J. B. Harrison, whose "Geology of the Goldfield of British Guiana," published in 1908, included con tributions by Perkins. He received the I.S.O. in 1904 and in the following year was appointed Surveyo General of British Honduras, where he later becam a member of the Executive and of the Legislativ Council.

WE regret to announce that Gerard Kalshoven Gude the authority on tropical land mollusca, died o November 8. Born in 1858, he was of Dutch parentage Acting as secretary to Messrs. Veitch of Chelsea i earlier years, he had for several decades devote himself to the study of land mollusca, contributing volume on that subject to the "Fauna of Britis India." Mr. Gude also studied and arranged th important series of Tertiary land and freshwater shell of Europe for the Geological Department of the Britis Museum. A constant visitor to the Museum, his information was freely at the service of his colleagues by whom he was greatly esteemed. He had been secretary and president of the Malacological Society o London.

WE regret to announce the following deaths:

Sir Maurice Fitzmaurice, C.M.G., F.R.S., president in 1916–17 of the Institution of Civil Engineers, and formerly a member of the advisory council of the Science Museum, on November 17, aged sixty-three.

Dr. Gustav Jaumann, professor of physics in the German Technical High-School in Brunn, and a foreign associate of the Vienna Academy of Sciences.

Current Topics and Events.

A REPORT on the "White" Indians discovered by Mr. R. O. Marsh on the Chucunaque River, to whom Mr. Julian Huxley referred recently in our columns (September 27, p. 464), appears in *Man* for November. It is the result of an examination made by Dr. F. C. Shrubsall, Dr. A. C. Haddon, and Mr. L. H. Dudley Buxton at Prescott, Ont., during the recent visit of the British Association to Canada. The party brought by Mr. Marsh from Panama consisted of two "white" boys and a girl, the parents of the girl, who are brown, and two San Blas Indians from an adjacent area. The "white" subjects, except in pigmentation, are identical with the brown in physical characters. They are very sensitive to light, and their vision is subnormal. All show rapid lateral nystagmus, and the younger boy occasional rotary nystagmus. The irides are greyish violet, with increased pigmentation at the papillary margin, and in one case a certain amount of brownish coloration. Choroidal pigmentation is markedly deficient. The hair is light golden and straight, the eyelashes nearly white. The skin is white with a rosy tint. Yellow brown freckles and blotches appear on the exposed parts. The parents of the girl are normal, but the maternal grandmother is said to have been white. The conclusion of the report is that the "white" characters are due to albinism and are of no racial significance.

THE report of the administrative council of the Empire Cotton Growing Corporation for the first full year since the passing of the Cotton Industry Act on July 18, 1923, has just appeared, and is a record of much valuable work. The Corporation is now firmly established, and at the moment its funds show an excess of income over expenditure, though if the cultivation of cotton in the British Empire should succeed as is hoped, there will soon be need for every penny. Signs of success are already visible in the rise of the exports from such colonies as the Sudan or Uganda; in the latter the crop is expected to reach 120,000 bales this season, a handsome figure, though as yet small compared to the 12½ million bales of the United States, or even to the 750,000 bales of Brazil, another country of recent appearance upon the market. It must never be forgotten in this connexion that the pioneer work in the British colonies was chiefly done by the British Cotton Growing Association, founded for the purpose more than twenty years ago. This Association is now attending more to the marketing work, leaving the propaganda, cultivation, and so on, to the larger organisation of the Empire Cotton Growing Corporation.

AMONG the most important activities of the Empire Cotton Growing Corporation at the present early stage are those recorded upon the first two pages of the annual report. By representation, protest, and otherwise, it has been largely instrumental in promoting the great Gezira irrigation scheme, which will render a very large area in the Sudan available for cotton, as well as in promoting the extension of railways in Uganda, Tanganyika, and South Africa, and in other ways. The most promising portion of the Empire is undoubtedly Africa, but cotton is much hampered there at present by lack of transport facilities. In this connexion attention may be directed to the interesting experiment described in the report; two lorries of "caterpillar" type have been sent out to Nigeria for trial upon unmade roads. It seems possible that such vehicles may prove to be available for the transport of cotton over untouched country, while at the same time consolidating the tracks upon which they move. Great enthusiasm is being shown in taking up cotton in Queensland, New South Wales, and South Africa, and fairly rapid progress is also being made in parts of tropical Africa. A considerable number of men (passed students, as well as senior men) has been sent out during the year to Uganda and elsewhere to aid in cotton work. The number of students has been increased, and a large sum has been provided for the keeping up of scientific work in various universities and other institutions. We wish all success to the efforts of the Corporation in its great Imperial task.

IN the *Times* of November 10, reference is made to a recent discovery of oil at Gabian, between Béziers and Paulhan, Dept. of Hérault, France. Within the last few years there have been several reports of the location of petroliferous deposits, mainly in central and south-eastern France, but save for the actual records of such discoveries, little seems to have been heard of any subsequent industrial developments on a large scale. From geological considerations, this is largely what was to be expected, though in the present oil-find at Gabian, if initial output is anything to judge by, prospects are better than might otherwise be anticipated. The search for petroleum throughout likely areas in France has been carried on arduously under the guidance of the Ministries of Commerce and Public Works, and in this connexion more than 12,300 acres of potential oil-bearing territory in the Gabian district have been acquired for the State. On behalf of the Ministry of Commerce, the Pechelbronn Company conducted drilling operations, which resulted in the bringing in of a well with a production of 250 gallons per hour of a fairly light oil (specific gravity 0·84). This well came in as a gusher, and it is because of its performance that considerable optimism prevails as to the future of this region of France as a productive oilfield. It is early days yet to form any definite ideas as to the possibility of this area from a commercial point of view; geologically there is much to be said against the likelihood of commercial pools being located, though the actual presence of petroleum is by no means contrary to expectation. But in this, as in other cases of petroleum occurrences in Western Europe, it is not the location of the oil which is surprising but rather the undaunted energy shown in the persistent search for economically valuable oil pools in the face of so many past negative results. Nevertheless, this discovery at Gabian is regarded as being the most important of its kind yet made within French territory.

VOLUME 68 of the Memoirs of the Manchester Literary and Philosophical Society contains an interesting account of the early domestic history of the Society, by Mr. Francis Nicholson. The Society was founded in February 1781 with 25 members, four of whom were fellows of the Royal Society and five are noticed in the "Dictionary of National Biography." Within a year of its foundation, it elected Joseph Priestley as an honorary member, and in November 1785 remitted to him 50*l*. as a tribute of respect and for "promoting and extending his philosophical pursuits." John Dalton removed from Kendall to Manchester in 1793 to take up the post of tutor in mathematics and natural philosophy at the Manchester Academy, founded in 1786 as a place of education of university standard without religious tests. On the removal of the Academy to York in 1799, he remained in Manchester as a teacher of mathematics and chemistry. He was secretary of the Literary and Philosophical Society from 1800 until 1809, when he was elected a vice-president and in 1817 president, an office he held until his death in 1844. One of the most interesting documents Mr. Nicholson brings to light in his history is a letter of Dalton's dated February 1794, in which he describes how he discovered the previous summer that colours appeared different to him from their appearance to other persons and how he was investigating the peculiarity. He never married, but this letter appears to indicate that if his head had not been, to quote his own words, "too full of triangles, chymical processes and electrical experiments, etc., to think much of marriage," he might have been.

THE Physical Society of Frankfurt-am-Main is preparing to celebrate its centenary.

PROF. M. DOELLO-JURADO, of the University of Buenos Aires, has been appointed as from January last to be director of the National Museum of Natural History at Buenos Aires.

PROF. A. S. EDDINGTON, Plumian professor of astronomy in the University of Cambridge, has been awarded the Bruce Medal of the Astronomical Society of the Pacific, "for distinguished service to astronomy."

APPLICATIONS are invited by the British Boot, Shoe, and Allied Trades Research Association, 50 City Road, E.C.1, for the posts of applied mathematician and assistant physicist. The applications should be sent to the secretary of the association.

THE Council of the Röntgen Society has decided to present the Röntgen Award for the session 1923–1924 to Mr. L. H. Clark, of the Physics Department, Middlesex Hospital, for his papers (1) "A Clinical X-Ray Balance Radiometer," and (2) "On the Measurement of X-Ray Intensity."

UNDER the Peter Le Neve Foster Trust, the Council of the Royal Society of Arts is offering a prize of 25*l*. for an essay on "The Effect of Trade Union Regulations on Industrial Output." Competitors must send in their essays not later than March 31, 1925, to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.2.

THE Stockholm correspondent of the *Times* states that after a long discussion the Swedish Academy of Sciences has decided not to award the Nobel Prizes for chemistry and physics for 1924, but to reserve them another year. It was announced recently that the Nobel Prize for medicine for 1924 had been awarded to Prof. W. Einthoven, professor of physiology in the University of Leyden.

THE October issue of *The Fight against Disease*, the official organ of the Research Defence Society, contains among other matter an interesting historical account of the discovery of the lacteals by Asellius in 1622, of Sir Charles Bell's differentiation of the different functions of the anterior and posterior spinal nerve roots, and of Claude Bernard's observations on vaso-motor nerves—all of them epoch-making discoveries in the annals of physiology.

IN many investigations concerned with the nature, transmission, and prevention of human diseases, experiments on monkeys afford the best hope of a solution. In temperate climates these animals are difficult to keep for any long periods, and to overcome this difficulty the Pasteur Institute of Paris has established a laboratory at Kindia, French Guinea, particularly for research in which the higher and lower apes are employed. A detailed and illustrated account of the Kindia laboratories is given by Dr. Calmette in *La Nature* of October 25.

THE National Union of Scientific Workers, 25 Victoria Street, Westminster, S.W.1, has recently published a suggestive pamphlet "On the Encouragement of Fundamental Research," being a report of the Research Committee of the Union. Several important aspects of research training and application are surveyed in the report, and a progressive policy is outlined. We hope to deal in a later issue with some of the points raised, but meanwhile we are glad to direct attention to the pamphlet, copies of which can be obtained at the offices of the Union, price sixpence each.

THE following officers for the session 1924–25 have been elected by the London Mathematical Society:—*President*, Prof. A. L. Dixon; *Vice-Presidents*, Prof. L. N. G. Filon, Prof. H. Hilton, and Prof. W. H. Young; *Treasurer*, Dr. A. E. Western; *Secretaries*, Prof. G. H. Hardy and Prof. G. N. Watson; *Other Members of Council*, Prof. S. Chapman, Miss H. P. Hudson, Prof. G. B. Jeffery, Prof. A. E. Jolliffe, Mr. J. E. Littlewood, Prof. A. E. H. Love, Prof. L. J. Mordell, Mr. H. W. Richmond, and Mr. F. P. White.

THE Institution Medal of the Institution of Automobile Engineers has been awarded as follows: to Dr. R. Ormandy, in connexion with the editing, checking, and preparation of the matter for the report of the Empire Motor Fuels Committee, recently published as a volume of Proceedings of the Institution; to Mr. Geo. W. Watson, for his paper on "Standardisation," which formed the subject of his presidential address before the Institution; and to Mr. H. G. Burford, for his services in connexion with the co-ordination of the relations between the Institution,

the S.M.M.T., and the B.E.S.A. This Medal, which was recently established, is awarded for any paper or similar service which may be considered likely to have a special influence on the advancement of automobile engineering.

RECENT visitors to the Museum of the Brooklyn Institute of Arts and Sciences will have noticed its congested state and will be glad to learn from Mr. A. H. Fox's Report for the year 1923, lately received, that the city has appropriated 1,050,000 dollars for the completion of two new sections of the building. It is hoped that these will be available in a few months' time. We are informed that the city has also recently completed the purchase of a house adjoining the present Children's Museum; so that institution will otherwise have more space for the admirable educational work that it conducts under the inspiring leadership of Miss Anna Gallup.

ABOUT two years ago the Trustees of the British Museum (Natural History) decided to catalogue and label all type specimens of Rhopalocera (butterflies) in the collections. Until recently many undoubted type specimens stood in the collections without any indications of their unique character. As a consequence some were discarded and replaced by "better" examples. It is, therefore, gratifying to know that proper measures are now being taken to ensure against the recurrence of such treatment. The first instalment, Part I., Satyridæ, has recently come to hand, and in it are listed some 3900 type specimens. The work was commenced by Mr. N. D. Riley, but the greater part of it has been done, under his supervision, by Mr. A. G. Gabriel. The catalogue gives the Museum number, name, genus under which originally described, original reference, sex, date, etc., of each type, and it will prove valuable to the systematist.

THE second annual report of the director of the Institute of Science and Industry of the Commonwealth of Australia covers the period from July 1922 to December 1923. It appears from it that the Institute, although established in 1920, has not yet been provided with the funds necessary to enable it to carry out the whole of its functions. The total sum available for its work in 1922-3 was only 13,900*l*., and the grant for the following year 12,900*l*. It is carrying out researches on pottery, paper pulp baking, the supply of tannin, seed improvement, agricultural pests, and stock diseases. No funds have, up to the present, been devoted to the study of the refrigeration problems which are in urgent need of solution, nor have any steps been taken to organise the information available as to ore deposits and the best methods of treatment of the ores. There is no lack of problems awaiting solution which cannot be touched until more financial aid is available.

WE learn from *Science* that at the stated meeting of the Franklin Institute held on October 15, the following medals were presented: The Louis Edward Levy Medal to Dr. Harvey Fletcher, of the Western Electric Company, New York City, for his paper on "Physical Measurements of audition and their bearing on the theory of hearing," printed in the issue of the Journal of the Franklin Institute for September 1923 (this is the first award of the Levy Medal, which is to be given annually to the author of a paper of especial merit, published in the Journal of the Institute, preference being given to one describing the author's theoretical and experimental researches in a subject of fundamental importance); the Edward Longstreth Medal to Thomas C. McBride, of Philadelphia, for his invention of a locomotive feed water heater, and to Milton Roy Sheen, of Philadelphia, for his invention of the expansion machine for tunnel construction.

THE autumn conversazione of the Natural History Museum Staff Association, which took place on November 12, attracted an unusually large gathering. Sir S. F. Harmer, the Director of the Museum, gave a short talk, illustrated by lantern slides, on the British Museum Australia Expedition. The exhibits shown included some of the more important specimens collected by the Expedition, among them being new and rare reptiles and batrachians, freshwater crustacea, mammals and birds, mainly from northern Queensland. Besides these, the general exhibits included a large number of interesting specimens recently added to the Museum collections. A selection was shown of the large consignment of mineral specimens which Dr. L. J. Spencer, while in Canada in connexion with the meeting of the British Association for the Advancement of Science, was instrumental in acquiring for the Museum. A selection of the Philip Roscoe bequest of Lower Carboniferous fossils, and also Ammonites from East Devon and West Dorset, were shown. A fruiting branch of the "Creeping Fig" was interesting for two reasons: because the plant possesses dimorphic foliage, and because the specimen illustrates a method of plant preservation by the use of copper acetate. Among the insect exhibits were insect remains found in oil-sand from Trinidad, and *Chrysops discalis*, a recent addition to the known disease-carrying Diptera. Other exhibits that may be mentioned were arachnids from Mt. Everest, from an altitude of 14,000 to 22,000 ft.; a new species of shrew from the Scilly Islands; a rare deep-water genus of Alcyonaria; skeletons of two very rare flightless birds from Madagascar; and series of specimens to illustrate the reduction of limbs and digits in lizards, and the evolution of planorbid shells in the Steinheim Basin.

METEOROLOGICAL information of considerable interest to seamen is given in the *Marine Observer* for November. Observations of various degrees of minuteness are made and supplied to the Meteorological Office by commanders of vessels in the mercantile marine and by some of His Majesty's ships; the logs of the latter are, however, always available for use through the Admiralty. In addition to the ordinary meteorological log and other means of registration, special reports are made by observers on matters and experiences of note, likely to be of interest to seamen generally, and many of these are included in the publication, together with a list of all who take any part in supplying regular information. "Wireless and Weather" data are regularly given, each monthly number containing usually some new feature, and

what is given will aid commanders materially in drawing for themselves special weather charts from wireless information, enabling them to know the weather conditions in which they are situated. An article is given on South Pacific hurricanes, prepared by Mr. H. Keeton of the Marine Division. The frequency and season of the hurricanes are dealt with, together with the tracks, rate of travel, and useful information with respect to neighbouring "hurricane warning stations." An illustration appears of the memorable escape of H.M.S. *Calliope* from Apia Harbour, Samoa, during a severe hurricane on March 16, 1889.

A BOOK of topical interest is announced for publication early in the new year by Messrs. Ernest Benn, Ltd., namely, "Radio: Beam and Broadcast, its story and patents." It is by A. H. Morse, late of the Marconi Wireless Telegraphy Co. of Canada, and purports to be the first published critical and constructive history of the development of wireless telegraphy and telephony. A feature of the work is the attention given to British and American patents.

MESSRS. Henry Sotheran and Co., 140 Strand, W.C.2, have just issued a new part of their "Catalogue of Science and Technology," namely, Part V., including VI., Physics, covering the letters S to Z, and containing a Supplement. This special catalogue of Messrs. Sotheran needs no recommendation, being well known for its valuable bibliographic notes, and the number of choice and rare books offered for sale. The new section is no exception. Copies of the catalogue are obtainable upon application.

MESSRS. Baird and Tatlock (London) Ltd., 14-15 Cross Street, Hatton Garden, London, E.C.1, have issued volume 4 of their Standard Catalogue. It is a quarto volume of 640 pages, well printed and illustrated, and covers the subjects of mechanics from hydraulics to aeronautics, heat including steam and internal combustion engines, light including radiology, sound and magnetism and electricity with their applications in industry. In order to give the users of the catalogue more liberty of choice, apparatus has been included which, although not made by Messrs. Baird and Tatlock, is guaranteed by the firm. The prices quoted represent present-day costs, and it is hoped that reductions in the cost of materials and labour will admit of their reduction in the near future; if this should be so, clients will reap the benefit. Amongst the newer apparatus catalogued we notice a universal bosshead clamp, a Langmuir condensation pump, a Duddell oscillograph, and a considerable range of wireless and X-ray apparatus.

Our Astronomical Column.

FIREBALLS.—Mr. W. F. Denning writes that a very brilliant fireball was observed from many places in Cornwall and Devonshire on Sunday, November 2, at about 10.55 P.M. A loud detonation was heard by various persons at about the same time, and the inference is that the noise was connected with the meteor. Observations are coming to hand which will enable a suitable investigation to be made and the real path of the meteor to be determined. It lit up the countryside with dazzling effect, and must have been one of the finest objects of its class.

Another object of similar kind was witnessed from the north-east region of Ireland on Tuesday, November 11, at 5.40 P.M. This fireball was remarkable for the length of its flight and its long duration. It traversed a path of about 124°, from the southern limits of Aries to near the star Cor Caroli, in about 20 or 25 seconds. The apparent size of the fireball was estimated to be about half that of the moon.

Mr. E. G. Fenton writes to say that he observed this meteor at Corbally, Limerick. It appeared in the eastern sky and moved slowly in a horizontal course from south to north. It was about four times as bright as Venus when at its brightest and of a bluish colour.

THE EFFECT OF SECULAR DIMINUTION OF MASS.—Dr. J. H. Jeans read a paper on this subject at the November meeting of the Royal Astronomical Society. It was based on Prof. Eddington's paper of last March, in which the conclusion was drawn that the luminosity of a star is simply a function of its mass, so that as the luminosity declines the mass does so likewise, through the conversion of part of it into radiant energy. Applying this to the sun, it was shown that its mass must be diminishing by millions of tons every second. This has an effect on the orbits of planets, the major axis of an orbit being inversely proportional to the mass of the central body. Dr. Jeans applied this principle to the development of the double-star systems, and found on certain hypotheses that the indicated age of the sidereal universe is of the order of 10^{14} years. This much exceeds previous estimates, and on the assumption that planetary systems arise from the close appulse of two suns, it is no longer necessary to assume that such systems are extremely rare. On the greater time-scale they might be expected in a large percentage of cases, especially as the stars were presumably closer to each other in early days.

Dr. Jeans further showed that motion in equiangular spirals would arise if the central body were losing mass very rapidly. This would, however, imply much higher brilliance in the central regions than that found in the spiral nebulæ.

THE DOMINION ASTROPHYSICAL OBSERVATORY, VICTORIA, B.C.—The output of work from this observatory has been of such interest and importance that many will welcome the detailed description of the 72-inch reflector that appears in the *Observatory* for November. There was great good fortune in the safe arrival of the disc from the St. Gobain factory, as it left Antwerp only a week before the outbreak of War. It has a central aperture 10 inches in diameter for use with the Cassegrain mirror. The principal focal length is 30 feet, that with the Cassegrain mirror 108 feet.

The arrangements for mounting and supporting the mirror, for keeping the temperature constant, and for giving the telescope large and small motions (which are effected by electric motors) are fully described and appear to be admirably efficient. There is a special car for removing the mirror for resilvering, which is done about three times a year.

The spectroscope is attached below the mirror, being used with the Cassegrain mirror. One, two, or three prisms can be used. When three are in use, the star spectrum is about 4 inches long.

Some important results on radial velocities, spectroscopic parallaxes, and the O type stars have already been obtained and published.

Research Items.

THE AMORITES.—In the current issue of *Ancient Egypt*, Prof. Sayce adduces further arguments for identifying the Amorites with the Mitanni rather than with the Western Semites as usually assumed. The geographical evidence is that the early Babylonians called the inhabitants of the plateau on both sides of the Tigris Subaru—"The Highlander," and that a portion of this territory came to be called the land of the Murrû after the Mitannian occupation. The historical evidence is that the earliest known king of the Amorites, Aqwaruwas, bears a Mitannian name. In the Tel el-Amarna age, Mitannian names are still mixed with Semitic. The philological argument is based upon the identity of Murrû as used by Sumerians for "Amorite" on one hand, and by the Mitannians and Hittites on the other, as the name of the Mitanni country, Amurru with the prothetic *a* appearing only in the Semitic languages. The argument from ethnology is that the Mitannians, speaking an Asianic language, originated in Asia Minor and belonged to the white races of Asia Minor and Europe. Hence they appear in the Egyptian monuments as blond, tall, long-skulled, with blue eyes and black or red-brown hair; they may be connected with the Libyans, the Berbers of to-day. They were the precursors of the Hittites in Palestine and Syria, and possibly represent the dolichocephalic neolithic population of Palestine. Their penetration to Babylonia in the semi-mythical age may explain why the Sumerians distinguish themselves from the earlier inhabitants as "the black-headed" race.

AGRICULTURAL RITES AND THE KINGSHIP.—Sir William Ridgeway, in a communication to the Cambridge Philological Society, (Proceedings CXXIV.-XXVI.) criticises the methods of Manhardt and Frazer as applied by Miss Philpotts, Miss Jessie Weston, and Dr. B. Malinowski. In the case of Miss Philpotts, he shows that the evidence relating to kings in early Scandinavia points to their being, not god-kings, but war-kings. The absence of weapons in the burials is the practice of the later Iron Age, and no warrant for the assumption that they were the graves of temple kings. There is no evidence for a fertility drama. The performances interpreted in this sense are part of the rites of Frey, the king to whom the Scandinavians believed they owed good harvests. They thus fall into line with dramatic performances in other parts of the world in honour of ancient kings and chieftains. Miss Weston maintained that Tummuz could not be regarded as ever having been a man; yet it had been shown that in the first two dynasties of Kish and Erech "gods mingled with men on earth" and Sargon of Agade began his career as a cup-bearer of a deified king of Kish. Dr. Malinowski, while asking how magical influence can grow into political power, thinks that he has found in Eastern New Guinea a situation such as that postulated by the "Golden Bough." In each community is a garden magician, the head man, who performs his ritual for public benefit. But he gives no account of the machinery by which the chief promotes fertility. In the ancestor-worship of China, Japan, India, and elsewhere, and in New Guinea itself, we have the machinery. It is clear that ancestral spirits are held to control the crops. Further, in the account of the Trobriand chief, it is not shown what is the basis upon which the position rests. It is not magic, as the chief "has the best sorcerers at his command"; but it is apparent from Dr. Malinowski's statements that he is a military potentate. He and his ancestors owe their high rank to personal prowess.

FAUNA OF THE PEAT MOOR.—Complementary studies to those of the botanist upon the characteristic vegetation of peat are now in progress by the zoologist, and a preliminary descriptive account with lists of species is published by O. Harnisch in the *Biologisches Zentralblatt* (vol. 44, pp. 110-127, 1924). The author points out that his results are in agreement with the generalisation that an extreme habitat tends to be occupied by relatively few species represented by very large numbers of individuals, but he has also a number of interesting species to record which, though perhaps localised to this habitat, occur relatively rarely. He directs attention specially to the characteristic Rhizopod fauna associated with sphagnum, which he regards as the oldest element of the characteristic moor fauna.

VARIEGATION IN LEAVES.—As a result of the study of chlorotically variegated leaves, Seigo Funaoka proposes the following classification of the various forms (*Biologisches Zentralblatt*, 44, pp. 343–384, July 1924), based upon anatomical investigations. I. Variegation without modification of structure, including (1) periclinal chimæras, (*a*) white over green, and (*b*) green over white; (2) mosaic (aclinal) variegation, (3) variegation with gradual transition zones. II. Variegation associated with structural modification, of which two types are distinguished, (*a*) *Richardia Elliotiana*, neither palisade nor spongy parenchyma of the green leaf takes part in the formation of the white areas; (*b*) *Euphorbia marginata*, spongy parenchyma forms the white variegated region, the green spongy tissue of normal area passing over into white tissue in a brief transition zone. In an earlier number of the same journal (pp. 309–336, June 1924) Otto Renner studied the variegated mottling of Œnotheras of hybrid origin. He concludes that the differences in chromatophore structure must arise through mutation, and that we have to reckon with plastids and cytoplasm in problems of heredity, as well as with the cell nuclei.

THE SEDGE *CLADIUM MARISCUS* IN NORWAY.—One of the rarest plants in Norway is this sedge, which has so wide a distribution in South, West, and Middle Europe. Though it has occasionally been mentioned from the time of Bishop Gunnerus, great doubt attaches to all the determinations, and the only certain record is that by R. E. Fridtz, who, in 1871, found it near Kristianssand. In 1922, Dr. Jens Holmboe was so fortunate as to chance on it in a little tarn called Tveitavatnet, near Lervik. Here it grew at the end of a small promontory of sphagnum and other bog plants, and was itself associated with *Menyanthes trifoliata* and *Lysimachia thyrsiflora*. The underlying rock is a micaceous shale, but limestone crops out not far away. In "Bergens Museums Aarbok" for 1922–23, Dr. Holmboe seeks to trace the origin of these occurrences by a consideration of the fossil evidence. He concludes that, like *Hedera Helix*, Cladium entered Norway from Southern Sweden, where it already existed in late Glacial times, as the climate grew warmer. It then attained in the south and south-west coast districts of Norway a wider distribution than at present. Whereas the ivy is still stretching northwards along the west coast and cannot be said to have reached its possible limits, Cladium long ago reached its climatic boundary, and has since then shrunk to the couple of relict-occurrences herein noted. These conclusions may be commended to students of the "Age and Area" hypothesis.

STRUCTURE AND METAMORPHOSIS IN THE HIGHER DIPTERA.—In the case of the Cyclorrhapha, or higher Diptera, the characters separating most of the families represent but comparatively trivial departures from a uniform type of structure. The thorough elucidation of the morphology and development of a single well-chosen example will largely explain the features common to an enormous assemblage of species. The economically important apple maggot (the larva of *Rhagoletis pomonella*) is selected by Mr. R. E. Snodgrass with this object, and he has recently published (*Journal of Agricultural Research*, vol. xxviii., No. 1, April 1924, 36 pp., 6 pls.) an account of his conclusions which is worthy of consideration by students of insect morphology. The apple maggot lives a concealed existence within the fruit of the apple, safe from enemies and surrounded by the abundant pulp which serves as its food. Mr. Snodgrass suggests that the ancestral larvæ took to living in mud or stagnant water and, in adaptation to this environment, they developed a pair of secondary dorsal spiracles at one or both extremities of the body in connexion with the dorsal longitudinal tracheal trunks. The primitive spiracles associated with the lateral tracheal trunks became closed: their former presence is indicated by the functionless stigmatic cords which have been noted in several diverse types of dipterous larvæ. With further study it is likely that these vestiges will be found to be universally present. This adaptive change outlined by Mr. Snodgrass is found in all larvæ of Cyclorrhapha, and it is evidently advantageous since it has fitted them for varied modes of life. The larvæ of the higher flies therefore discard the primitively lateral spiracles and develop breathing-organs in relation with the dorsal tracheal trunks. The pupa retains the anterior spiracles of the larval system while the imago discards the larval spiracles and returns to the primitive or peripneustic tracheal system. Attention may also be directed to the interpretations given of the development of the larval pharynx and mouth-hooks, the pupal envelopes and the rôle of phagocytes in histolysis.

GEOLOGY AND GEOGRAPHY OF ARCTIC CANADA.—Some important geographical and geological work along the Arctic coast of Canada is published in volume xi. of the Report of the Canadian Arctic Expedition, 1913–18. The first part is a report by Mr. J. J. O'Neill on the geology of the coast west of Kent peninsula, including the Mackenzie delta and the valley of the Rae and Coppermine rivers. From his study of the deposits of the Mackenzie delta, Mr. O'Neill is inclined to believe that they are derived from material furnished by the Keewatin ice-sheet. The river brought these deposits to the coast and built them up at a rate greater than land was being lost by submergence. The growing delta was thus a barrier to the encroachment of the sea into the Mackenzie valley during the undoubted post-glacial submergence of the coast. A section of the report deals fully with native copper deposits in Arctic Canada. Vague reports of these occurrences have been circulated for many years, and it is now definitely known that deposits of native copper occur in the Coppermine valley and Bathurst Inlet. It probably is to be found also in central Victoria Island, and in Prince of Wales Island, and quite possibly in other places. It appears chiefly as amygdaloidal copper near the surface of lava flows. Mr. O'Neill goes on to discuss the commercial value of the deposits. The second part of the volume is devoted to geographical notes on the Arctic coast with a history of previous work by Messrs. K. G. Chipman and J. R. Cox. The volume contains a geological map of the coast between Darnley Bay and Bathurst Inlet.

METEOROLOGY AT SAMOA.—Reports of the weather at Apia Observatory, Samoa, for the years 1921 and 1922, together with a Summary of the Meteorological Observations for 1890 to 1920, by Dr. G. Angenheister, have recently been received. The annual reports give hourly observations of magnetic declination and of horizontal and vertical intensity with the monthly means for each hour. The seismological reports give a catalogue of earthquakes registered at the Observatory during the year. The annual report for 1921 gives only two pages to meteorology, the summary being of a very general character. In the report for 1922 daily meteorological observations are given. The summary of meteorological observations for the years 1890–1920 is very complete, and monthly means for each year are regularly given, together with the number of rainy days and the number of days with thunderstorms. In describing the climate of Samoa, it is mentioned that Samoa is exposed to the south-east trade wind, interrupted by westerly and northerly winds from December to March during the rainy season. The annual amount of rain increases very considerably with altitude, the mean increase being 18 per cent. per 100 m. The daily variation in the amount and duration of rain is, on the whole, semi-diurnal, with maxima in the morning and evening. In the trade-wind season there is only one maximum, at about 4 P.M. Observations are reported to show the 3-year period and the 11-year period. The instruments are supplied by the Seewarte, Hamburg. Numerous references are made to previous meteorological discussions of observations at Samoa, but no mention is made of observations in the years 1862–5 from instruments supplied by the Meteorological Department of the Board of Trade in 1861. These observations were taken by Mr. J. C. Williams, British Consul at Samoa, at the Consulate at Apia, a discussion of which was published in the Quarterly Journal of the Meteorological Society for July 1879.

SLOW AIR VIBRATIONS FROM LARGE EXPLOSIONS.—In the *Comptes rendus* of the Paris Acad. Sci., Oct. 6, M. P. Villard describes the register of air vibrations obtained at Paris by Dufour when the La Courtine explosions took place. Very considerable amplitudes were recorded with a frequency of about a second, the approximately sinusoidal motion lasting for about three seconds. This is about four octaves below the lowest audible note; there was no trace of audible frequency. It appears that, in all cases when large quantities of explosive are involved, the low-frequency waves, even at small distances, are much more important than the sound waves, which can be regarded as an accessory phenomenon. The author on one occasion was 1800 metres distant from a very violent explosion in an explosives factory; the sound heard was loud, but by no means deafening, being comparable with a short, loud thunder-clap. At the same time, although there was a calm, a breath of air was felt on the face, similar to that produced by the motion of a fan. This was the compression half wave of a movement with very low frequency, the amplitude being apparently several centimetres, of course enormous compared with that of a deafening sound. On another occasion a French window, which was unfastened, was opened about 10 cm. by the wave of compression of a similar explosion. On both these occasions windows were broken in the immediate neighbourhood by the pressure difference between the air outside and inside the buildings.

THE PLASTICITY OF ROCK SALT IN WATER.—This subject is discussed by Messrs. W. Ewald and M. Polanyi in the *Zeitschrift für Physik* of September 20. Various observations have recently been made on the

plasticity of wet rock salt; but the theories proposed to account for it do not agree. The authors have made additional measurements of the plastic bending of strips of rock salt in water, and conclude that the effect is due to a lowering of the elastic limit, which commences immediately in contact with water, and ceases when the surface is dried, or when the water is saturated with salt. The effect is observed, though not quite so strongly, when the upper compressed side of the bent prism is wetted. If only the lower side is wetted, the plasticity is scarcely observable (the prism or rod is supported at the ends and weighted in the middle). Apparently, at ordinary temperatures, the essential part of the resistance to change of form resides in the surface, and during the solution of the surface layers this resistance is removed. There is slip along the rhomb dodecahedron surfaces, and thus the layers of slip come to the surface, and fine steps or slip lines are formed. In the normal surface, the slip layers are locked in place. The breaking load was increased tenfold under water; this increase in strength is brought about by the lowering of the elastic limit. It seems to be possible to approach the molecular strength of rock salt, as given by Born's lattice theory. The subject is also discussed in a communication by Prof. A. Joffé, M. Kirpichewa, and M. Levitzky, which appeared in NATURE of March 22, p. 424.

SEASON-CRACKING OF BRASS.—The issue for October 10 of *Die Naturwissenschaften* contains an article by W. Masing on this subject. It has been shown by Moore and Beckinsale that the internal stresses due to severe cold-working, which are the cause of season-cracking, may be removed by annealing at a temperature much below that at which the brass is appreciably softened, and this has now become a usual practice. Thus annealing a 70 : 30 brass at 275° C. will remove internal stresses so that cracking no longer takes place on immersion in a solution of mercurous nitrate. The new experiments show that as the degree of cold-working increases, the liability to crack increases up to a maximum and then diminishes. This is explained by the fact that the action of the mercurous salt, as well as the failure in use, always proceeds along the intercrystalline boundaries. In a very severely cold-worked metal the structure becomes more confused, and it is suggested that chemical action along boundaries is thereby hindered. A different kind of cold-working, however, may again cause cracking. For example, a brass which has been reduced 40 per cent. in section by cold-rolling no longer cracks under the test, but if bent or pressed into a dished form, the liability to cracking reappears. This may be explained on the basis of present views as to the fibrous structure imparted to metals by rolling, and revealed by X-ray analysis. Masing also endeavours to distinguish between gross internal stresses of this kind and microscopic distributions of stress, which he regards as responsible for increase of hardness, the latter only disappearing at a much higher annealing temperature.

FORMATION OF CRYSTALS.—In order to prove that the study of crystals is not only of academic interest, but has also important practical applications, it is sufficient to note that the Chemical Engineering Group of the Society of Chemical Industry has thought it worth while to persuade Mr. T. V. Barker of Oxford to present to it a paper on "The Development and Formation of Crystals" as a companion to a more directly utilitarian paper by Mr. H. Griffiths on "Mechanical Crystallisation" read on October 23. The latter paper is of interest because it shows that the general public has realised that a well-crystallised product is generally chemically pure (although it might contain isomorphous impurities), whereas a powder may be impure or even deliberately adulterated to any extent. It is, therefore, possible to secure much higher prices for a "pea crystal" quality, in which each crystal is a separate entity, than for a crushed aggregate such as is generally supplied when the traditional processes of "uncontrolled" crystallisation are used. In order to obtain individual crystals of uniform size, it is necessary to make use of "controlled" crystallisation, and special plant (usually a trough which can be rocked) has been devised, in which the rate of cooling and velocity of flow can be varied in such a way as to produce the desired effect. From the point of view of the consumer, it is eminently desirable that these methods should be developed as fully as possible, since there is no other method by which the uniformity and purity of a crystalline product can be so readily established.

THE POSSIBILITY OF THERMAL DISTURBANCE IN MICHELSON'S EXPERIMENT.—M. E. Brylinski has shown that, if a source of heat were situated in a definite position in the laboratory, such that differences of temperature of from 0·01° to 0·001° C. were produced between different parts of the apparatus, periodic phenomena similar to those observed by Miller in 1921 would be observed when the apparatus was slowly turned about its axis (*C. R. Paris Acad. Sci.*, Sept. 22). Such differences might easily result if one wall were warmer than that opposite, or might be due to the presence of the observers. It appears that the only way to obtain more precise results in the experiment would be to use a revolving table of invar. This would reduce the disturbances observed with Miller's cast-iron table to about one-tenth. It would be necessary to shield the apparatus from the earth's magnetic field, or to allow for its effect upon the invar table.

ACIDS, BASES, AND SALTS.—Prof. E. C. Franklin, in the October number of the Journal of the American Chemical Society, has an interesting paper on acids, bases, and salts, in which the old theory of types is revived and extended. Oxygen, sulphur, nitrogen, the halogens, and even carbon are acid, base, and salt-forming elements in the sense of Lavoisier's theory. Aquo-acids, etc., have analogies in the H_2S and NH_3 types; hydrazoic acid, formulated as $H-N=N\equiv N$, is related to ammonia as nitric acid, $H-O-NO_2$, is related to water, and the two acids have many properties in common. Many reactions in liquid ammonia are explained on this scheme. Hydrocyanic acid is formally ammonocarbonous acid, namely, NH_3, in which two atoms of hydrogen are replaced by the negative divalent carbon atom. Although zincates and plumbates are hydrolysed, the corresponding ammono-salts are readily obtained crystallised from liquid ammonia, by the interaction of metallic amides with potassium amide. The paper is full of interesting and ingenious suggestions.

FORMS OF MERCURIC OXIDE.—Although the red and yellow forms of mercuric oxide are generally supposed to differ only in fineness of division, the experiments of E. Cohen on the electromotive force of a cell composed of mercury in contact with the two forms in an alkaline solution led to the result that they are allotropic forms. The X-ray spectra of the two varieties have now been determined by G. R. Levi, who in the *Gazetta Chimica Italiana* for September shows that the crystalline forms of the red and yellow oxides are identical. Two photographs of the spectra are reproduced, which leave no doubt that the forms are not different modifications, and the usual theory appears to be completely confirmed.

The Trans-Canadian Excursion of the British Association and the International Mathematical Congress.

THE Toronto meetings of the British Association and the International Mathematical Congress in August were followed by an excursion from that city to Vancouver and Victoria and back. About 360 persons took part in it, mainly members of the Association from Great Britain, but including about two dozen members of the International Mathematical Congress from European countries, and a few Canadians and Americans. The excursion was generally voted a wonderful success and a most enjoyable and memorable experience. From a collection of notes and impressions from various sources, it is now possible to visualise something of its wide scientific interest.

The outward journey passed through the mining and agricultural districts of northern Ontario, and proceeded, by way of Winnipeg, Saskatoon, and Edmonton, to Vancouver, following the route of the Canadian National Railway, with the exception of a stage in northern Ontario on that of the Timiskaming and Northern Ontario Railway. The return journey from Vancouver was made over the Canadian Pacific Railway through the famous mountain scenery of British Columbia, and by Calgary, Regina, Fort William and Port Arthur, and Sudbury, to Toronto. The whole excursion represented 5396 miles of travel by rail; it lasted from August 17 until September 4, for almost the whole of which period the two special trains were the dwelling-places of the travellers, and the comfort of the provision made for them by the two great railways is attested by the absence of expressions of distaste for this mode of life, the habit of which was soon acquired. Moreover, the time-table of the excursion was arranged with extraordinary skill in regard to viewing points of interest, passing quickly over stages of least scenic attraction, and affording reasonable periods for rest. The generosity of provincial governments and the local committee in Toronto rendered it possible to make the journey at exceptionally cheap rates.

The excursion offered a measure of scientific interest in every department, though perhaps geologists, botanists, zoologists, and agriculturists found the widest scope. Quite apart from formal arrangements, botanists and entomologists were most conspicuous in their activities whenever the trains stopped at station or crossing, and it was possible, for however brief a period, to get out of them; the freedom of the Canadian railways in this respect was appreciated by all as a mere relaxation from travel, but it also afforded real opportunities for collecting. The economic and industrial activities of the provinces traversed; the inhabitants and conditions of life in town and country; the architectural and other developments in the greater cities, especially as realised by those who had previously visited them—these features, together with the natural beauties of the Dominion, afforded sufficiently varied interest for all the trains' company, and an enlargement of their scientific horizon. Nothing impressed the visitors more than the lavish ground-plans and beautiful buildings erected for such institutions as the Universities of Saskatchewan at Saskatoon and Alberta at Edmonton, and the Manitoba Agricultural College near Winnipeg, to which must be added the new site and designs for the University of British Columbia.

With these developments in view, it can scarcely be mere accident that the reception of the party in the visited cities differed materially from that encountered in 1909, when an excursion to the West was made after the Winnipeg meeting. Be it said at once, the high quality of Canadian hospitality does not vary. But the phase of speeches confined to words of welcome and imperial sentiment (things however admirable in themselves), the phase of frank confession that science and its aims were not understood, the phase of the triumphal arch and the town band—these seem to have passed away. Instead, the party on the present occasion was received with words which indicated a real appreciation of its mission; the scientific problems which are most closely allied with Canadian progress were clearly pointed out, and visiting scientific workers were invited to inspect and participate in the results of Canadian research. From every principal stopping-point came requests for some form of scientific communication from members of the party, and in two instances, as will be seen, there were actual sessions of some of the Sections of the Association.

Parties of geologists and botanists left Toronto in advance of the main body, to spend additional days in northern Ontario in investigation respectively of the mineralogy and the forest and plant phenomena of that region. The main body viewed the mines and process of extraction at Cobalt, Kirkland Lake, and Timmins, and the power plant and paper mills at Iroquois Falls, with its "garden city" separated by many miles of forest from any other considerable centre of population. Agriculturists left the trains at Cobalt for a short run by motor-car through a portion of the "clay belt," to view the recent extension of farming there and to visit the Dominion Experimental Farm. At Swastika, some of the members of the Anthropological Section called upon a family of Londoners, whose improved circumstances since emigration greatly impressed them.

At Winnipeg, Man., nearly the whole party was entertained at the Manitoba Agricultural College; economists and others visited the grain exchange; a geological party went to Stony Mountain to study the Upper Ordovician rocks of the district, and a party of engineers and others was taken to the municipal hydro-electric plant at Point du Bois, 78 miles from the city, incidentally viewing some interesting features of Galician and other settlement in the district.

At Saskatoon, Sask., proceedings began with the formal opening of the new chemistry building in the University of Saskatchewan. Sectional sessions then took place, in chemistry with a discussion on photosynthesis, in zoology and agriculture jointly on the subject of animal diseases, and in geology. Agricultural and experimental grounds and stock-yards, the clay deposits of the neighbourhood, and other features of scientific interest were seen, and members interested in overseas settlement saw something of the homes of the people. In the evening a public lecture was given by Dr. E. E. Slosson on photochemistry and modern civilisation.

At Edmonton, Alta., there were sessions of the Sections of Physics, Geology, and Botany and Agriculture (jointly). Special geographical, geological, and agricultural parties were formed to see things of particular interest to them. In the evening a public meeting was held in the convocation hall of the University, when addresses were delivered by Sir John Russell, Sir William Beveridge, and Dr. J. S. Flett. Some of the botanists left the main excursion at Edmonton for a journey by motor-car through central Alberta and thence into the mountains, rejoining the rest at Banff.

The main excursion, after leaving Edmonton, called at the mountain resort established by the Canadian National Railway in Jasper Park, where the members were guests of Sir Henry Thornton, general manager of the railway. At Vancouver and Victoria, a most interesting and varied programme was arranged. Stanley Park, the Fraser lumber mills, the Capilano Canyon, a settlement of Squamish Indians on the north side of the harbour, the beautiful fiord of Howe Sound, with the Britannia copper mines above it, and the power plant at Lake Buntzen were among the points visited from Vancouver by members concerned with their several scientific interests; while at Victoria the astrophysical and meteorological observatories, the museum, some old Indian village sites, and the beauties of Butchart's Gardens and the gardens of Government House, with several localities of botanical interest, were inspected. A number of lectures were given in Vancouver at public meetings or to societies and clubs, the speakers including Prof. G. W. O. Howe on radio-telegraphy, Dr. A. W. Borthwick on forestry, Prof. W. T. Gordon on gem stones, Prof. W. W. Watts on buried landscape, Dr. and Mrs. Shrubsall on physical and mental welfare, and Dr. Ivy Mackenzie on physiological discoveries of importance to the man in the street. The president, Sir David Bruce, met members of the Vancouver Medical Association. Mr. O. H. T. Rishbeth gave a lecture on modern geography at New Westminster. Marine biologists visited the well-known station at Nanaimo.

Three beautiful days were spent on the mountain section of the Canadian Pacific Railway, with calls at Glacier, Lake Louise, and Banff, and ample opportunity, thanks to the provision of open observation cars, to view the scenery between these points. A small party paid a private visit to the ranch of H.R.H. the Prince of Wales, near High River, Alta. The main party called at Calgary, Alta., where the oil refineries and other industrial establishments were seen, and at Regina, Sask., where addresses were delivered by Prof. D'Arcy Thompson, Sir Thomas Holland, and Dr. Marion Newbigin. From Kenora, Ont., trips were made on the Lake of the Woods, the limnologists working tow-nets and the geologists examining some of the islands. At Fort William and Port Arthur, the twin ports at the head of Lake Superior, arrangements for handling the grain export from the west were shown, and a geological party viewed the interesting features of Mount M'Kay and the vicinity. Brief opportunities for further field work were afforded by halts on the fine northern coast of Lake Superior, and the scientific investigations of the journey ended with the inspection of nickel and copper mines at Sudbury, Ont.

In this short narrative, no specific reference has been made to the generous hospitality extended to the travellers at every point by public bodies and private individuals. Luncheons and dinners, always admirably arranged, afforded an opportunity for general intercourse which was impossible in the dining-cars; and fleets of private motor-cars were placed at the disposal of the visitors in every city. All who took part in the excursion owe unqualified gratitude to its organisers and to those who made them their guests.

Pigments, Varnishes, and Building Stones.[1]

Early Methods of Oil Painting.

THE evidence to be obtained from ancient manuscripts as to early methods of oil painting has been re-examined. From this it is clear both from the manuscript of Theophilus and the manuscript of Eraclius that the properties of such drying oils as linseed oil and walnut oil were thoroughly understood so early as the twelfth century, if not earlier, and their preparation in a suitable condition for a painting medium and their use for this purpose.

The methods used in their preparation differ very little from the best practice of to-day. The refining and bleaching of the oil and the use of driers was well understood, and there was no indication in passing from these earlier recipes to those of the fifteenth century that any new discovery of importance was made at the time of the brothers Van Eyck. Passing to later times, Vasari directs that pigments are to be ground in walnut oil or linseed oil, and this is all that is necessary, and he recommends the use of walnut oil as less liable to darken with time.

Many recipes for varnishes are given, and as neither spirits of turpentine nor alcohol were available in commercial quantities until the end of the fifteenth century, these varnishes are what we should now describe as oil varnishes, consisting of resins dissolved in hot oil. The natural balsams of the pine, resin, mastic, and sandarac, often all mixed together, were used in their preparation, the proportion of resinous material to oil being very high, and the varnishes consequently being very sticky and having to be heated and rubbed on with the hand. Spirit varnishes corresponding to the mastic varnishes of to-day are found in the sixteenth-century and later recipes.

The evidence of the accounts preserved at Ely and Westminster shows that both oil and varnish were used in painting on walls during the thirteenth and fourteenth centuries, this being the northern tradition, while the Italian tradition was the use of egg as a medium. There is no indication in these recipes of any special secret differing from what we know to-day; but it has been suggested by Prof. Berger and others that the early method of painting in the fifteenth century may have been with an emulsion of varnish or oil with yolk or white of egg, and two recipes, one in a Venetian manuscript of the fourteenth century and one in a Bolognese manuscript of the fifteenth century, are quoted in support of this theory.

It may be admitted that if these early painters wished to paint in varnish instead of in oil, they would have had to blend the varnish with white or yolk of egg to make it into a workable medium, and the question is worthy of further inquiry.

These early pictures were painted on a wood panel sometimes covered with strips of linen and coated with a gesso made of parchment size and whitening or plaster of Paris which had been soaked in water until it lost its binding properties. Recent experiments carried out by Mr. Thompson at the Heriot-Watt College, Edinburgh, on an old sixteenth-century panel, have revealed the fact that this panel was coated with a non-absorbent gesso upon which a very thin layer of absorbent gesso was laid, so as to ensure the binding of the oil to the surface of the gesso and, at the same time, preserve from staining the pure white surface of the gesso below. On this pure white gesso panel the picture was drawn in detail, and laid out either in monochrome or partly in colour with pigments probably mixed with size, and upon this the pigments ground in oil or, it may be, an emulsion of varnish and egg were laid, care being taken to paint the high lights very thinly as compared with the rest of the picture. In course of time the oil yellows and

[1] From lectures delivered on November 12, 13, and 19 in a course of six lectures to the students of the Royal Academy, London, by Prof. A. P. Laurie, professor of chemistry at the Academy.

the pigments, more especially the white lead, get more translucent. By painting the picture in this way, the artist ensures that the increased translucency of his white lead will correct the yellowing of the oil, owing to the white light reflecting from the gesso, and that his contrast of light and shade will be maintained owing to the laying out of his picture on the white gesso surface with pigments mixed with size, and owing to the fact that his high lights are thinly painted.

There is much more yet to be discovered as to these early methods, and the question as to whether varnish, emulsion, or oil was used has still to be finally cleared up; but we are, at any rate, increasing in our knowledge of their general methods of procedure.

Modern Pigments.

The pigments used by the artists of to-day can be classified into those that can be regarded as unchangeable, those that are moderately permanent, and those that are fugitive. This classification is based in the first place on the work done many years ago by the late Sir William Abney, but since then a good deal of additional information has been accumulated, and the leading artists' colourmen firms have themselves directed a considerable amount of attention to the subject, so that it is now possible to make a fairly sound classification of pigments suitable for oil painting, a more limited list for water-colour painting, and a still more limited list for fresco.

At the same time, there are a certain number of pigments which require further investigation, as their permanency seems to depend upon the method adopted in their manufacture, and they must at present be put on the doubtful list. These include the pale cadmiums, unless they have been specially manufactured for permanency. On the whole, the lists of permanent pigments drawn up by the various artists' colourmen will be found fairly trustworthy for practical purposes. It is also necessary not to use two pigments that act chemically upon each other, and it must also be remembered that the transparent blues and greens, when mixed with oil and laid pure on the canvas, unless in very thin glazings, tend to degrade, owing to the yellowing of the oil.

The oil painter to-day is faced with similar problems to those of the oil painter of the fifteenth century, namely, that a medium which yellows with age, and that certain pigments, such as flake white, grow more translucent with time, and therefore the permanent brilliancy of an oil painting, after having selected his pigments as advised by the chemist, depends on the technical skill of the artist.

Some English Cathedrals and Stone Decay.

The Cathedrals of Durham, Lincoln, Ely, and Norwich have been visited, and in addition the condition of the stone at Hampton Court and the Houses of Parliament has been re-examined.

The ruins of Elgin Cathedral were first discussed. In order to understand what is happening here and elsewhere it is necessary to classify the stones used for building into three main groups: the lime-stones, the sand-stones in which the quartz particles are united by calcite, and the sand-stones in which the particles are united by silica. This classification will be regarded by petrologists as wanting in detail and being somewhat diagrammatic in character, but it will be the most convenient for the present purpose, which is an inquiry into the injury caused to modern buildings by the presence of sulphur dioxide in the air produced by the burning of coal.

The ordinary causes of stone decay do not require special mention here as they are well known to architects and builders. The new and the main cause of the rapid decay taking place in modern buildings is the attack on the calcium carbonate of the lime-stone and of the calcite forming the binding material in sand-stones by sulphur dioxide in the presence of air and moisture, forming calcium sulphate. Calcium sulphate is slightly soluble in water, and therefore is being slowly dissolved in the rain and removed, but this is not the most serious cause of damage. Cases of rapid decay are found to be associated with the crystallisation of calcium sulphate inside the stone and the consequent breaking up of the stone.

In some cases where siliceous sand-stones have been used, the source of lime must be the mortar, the rain dissolving and washing the lime into the stone. Analyses at remote places like Ely and Tintern Abbey have shown that the destruction by the action of sulphur dioxide is not confined to the towns, but is spread over the remote country districts.

Probably the best thing that can be done is to treat such stone surfaces with a binding material depositing silica cement, and periodically to wash down the building with water during the summer with the view of removing the excess of sulphate of lime, and thus diminish the danger of crystallisation. While it is not possible in the state of our present knowledge to say whether such washing can be safely applied to every variety of lime-stone, experiments in this direction are well worthy of the serious consideration of architects.

British Institute of Radiology.

IN the issue of the *British Medical Journal* for November 8 an account is given of the new British Institute of Radiology. This is situated in Welbeck Street, W.1, the house of the old Russian Embassy. The Embassy consisted of a lofty, roomy house, and this has been altered and adapted to meet the needs of the new Institute.

The main objects of this—the first of its kind in Great Britain—are set out in full in the article in question, and are the outcome of joint deliberations between representatives of the British Association for the Advancement of Radiology and Physiotherapy (B.A.R.P.), the Royal Society of Medicine, and the Röntgen Society. Primarily, it may be said that the object of this Institute is to promote the advancement of radiology and physiotherapy on scientific lines under the direct control of the medical profession, protecting in every possible way the interests of those engaged in these subjects. Further, it is hoped to provide facilities for the delivery of lectures, the holding of classes and examinations, the establishment of scholarships, and the granting of prizes, diplomas, etc., in radiology and electrology. Arrangements are well in hand for the formation of a library and radiographic museum. These two features have been much helped by gifts of books from Lady Mackenzie Davidson and the presentation of radiographs from many interested in the Institute.

Membership of the Institute is, however, by no means restricted to the medical profession, for not only are physicists, engineers, and manufacturers of electrical apparatus eligible in this respect, but representatives of them have also from the first been invited to join in the discussions precedent to the formation of the Institute.

The present needs of the Institute are largely financial. It was helped at its formation by the action of the trustees of the Mackenzie Davidson Fund in

handing over a sum which had been publicly subscribed to perpetuate the name of Mackenzie Davidson. Even so, however, additional expenses have been incurred, and an appeal is now made for a sum of 6000*l.*, which will pay off arrears and allow for future developments.

Reference to this Institute would be incomplete without mentioning the name of Sir Archibald Reid. It was largely due to his untiring efforts that the Institute took shape when it did, and his memory is being perpetuated by the formation of a reference collection of radiographs, both normal and pathological.

The acceptance of the presidency of the Institute by Sir Humphry Rolleston, Bart., president of the Royal College of Physicians, is proof, if any were needed, of the interest of the medical profession in this venture and of their concern for its development. It is also one more instance of the many services which have been rendered by Sir Humphry Rolleston in the cause of medical radiology. S. RUSS.

University and Educational Intelligence.

CAMBRIDGE.—Mr. H. E. Tunnicliffe and Mr. N. J. T. M. Needham have been elected fellows of Gonville and Caius College. The John Bernard Seely Prize in aeronautics has been awarded to W. A. Johnson, Peterhouse, for an essay on "Dynamical Similarity and Scale Effects."

Dr. D. H. S. Cranage has been appointed secretary of the Board of Extra-mural Studies, and the Rev. J. W. Hunkin has been appointed secretary of the General Board of Studies.

The scheme for the creation of a class of extraordinary or visiting professors, to which reference has already been made in these columns, was rejected by one vote.

EDINBURGH.—The Prince of Wales has consented to open the new Chemistry Department of the University on December 3.

GLASGOW.—Mr. J. J. Lister has presented to the University the microscope used throughout his life by his uncle, Lord Lister, together with a number of auxiliary appliances and mounted preparations. The valuable and interesting relics will be placed, with the microscope of William Hunter, in the Hunterian Museum.

The microscope of Bentham, the botanist, has been presented to the Botany Department of the University by Mr. James Whitton, late superintendent of the city parks and gardens.

The Bellahouston Trustees have, in honour of the Kelvin Centenary, made a grant of 2000*l.* to the University for the purchase of modern electrical apparatus for the use of the Natural Philosophy Department, now under Prof. H. A. Wilson.

LEEDS.—We have already referred in these columns to the "Smithells Fund" which was being raised to commemorate the services of Prof. A. Smithells to the University. The Fund has now reached a total of nearly 2500*l.*, of which about one half represents contributions from the gas industry. A portrait of Prof. Smithells has been painted by Mr. Fiddes Watt for presentation to the University. The presentation ceremony will take place on November 25. The balance of the Fund will provide a scholarship, of approximately 100*l.* per annum, which is to be established in the University in the name and with the advice of Prof. Smithells.

THE Harper Adams Agricultural College, Newport, Salop, is requiring an analyst and demonstrator in its chemical department with, if possible, experience in agricultural-chemical analysis. Particulars are obtainable from the principal of the college.

THE following election results complete the list of Parliamentary representatives for the Universities of Great Britain and Northern Ireland:—OXFORD: Lord Hugh Cecil (U.) and Sir Charles Oman (U.); SCOTTISH UNIVERSITIES: Sir Henry Craik (U.), Mr. D. M. Cowan (L.), and Sir George Berry (U.).

MR. H. T. CRANFIELD, who has held the post of senior lecturer in agricultural chemistry and head of the Chemical Department at the Midland Agricultural and Dairy College for several years, has been appointed adviser in agricultural chemistry, under the Ministry of Agriculture scheme, for the Midland Counties served by that College.

THE council of the British Electrical and Allied Manufacturers' Association (Inc.) have recently granted the following scholarships and renewals of scholarship tenable for one year, each of the value of 100*l.*, together with the payment of college fees:—*In Electrical Engineering:* Mr. J. T. Birtwell, at the College of Technology, Manchester; Mr. G. E. G. Foden, at the College of Technology, Manchester; Mr. P. J. Maggs, at the City and Guilds (Eng.) College, South Kensington; Mr. H. G. Richards, at the University of Birmingham; Mr. R. Robinson, at the University of Durham. *In Mechanical Engineering:* Mr. J. C. Burke, at the College of Technology, Manchester. *Renewals of Scholarship:* Mr. A. B. Everest, at the University of Birmingham, for metallurgical research in relation to electrical engineering; Mr. I. H. Hedley, at the University of Durham, for electrical engineering; Mr. G. S. C. Lucas, at the City and Guilds (Eng.) College, South Kensington, for electrical engineering, to enable him to carry forward his studies in alternator design; Mr. B. S. Pelton, at the University of London, for mechanical engineering (steam turbines).

THE appointments to Ramsay Memorial Fellowships in chemical science for this session, British, Dominion, and foreign, are practically completed. At the present time sixteen fellowships are being held in the universities and colleges of the British Isles. The list of awards for the present session, together with the university or college which has been selected by the fellow for his research, is as follows: *British*—Dr. Samuel Coffey (University College, London), Dr. A. F. Titley (University of Oxford), Mr. Sidney W. Saunders (University College, London). *Glasgow*—Mr. T. S. Stevens (University of Oxford), Dr. Alex. Robertson (since resigned on appointment to an International Fellowship in New York). *Canadian*—Dr. Edward H. Boomer (University of Cambridge). *Danish*—Mr. Kai J. Pedersen (University of Bristol). *Dutch*—Dr. J. Kalff (University of Manchester). *French*—Dr. H. Weiss (Royal Institution, London). *Greek*—Dr. Nicolas Oeconomopoulos (University College, London). *Italian*—Dr. Antonio Nasini (University of Cambridge). *Japanese*—Dr. Kameyama (University College, London). *Norwegian*—Mr. Leif Lindemann (provisional). *Spanish*—Dr. Miguel Crespi (University College, London). *Swiss*—Dr. Walter Feitknecht (Royal School of Mines, London). The total value of the annual amount of the fellowships that is awarded is approximately 4800*l.*, of which approximately 3300*l.* is provided by grants from Dominion and foreign sources.

Early Science at the Royal Society.

November 23, 1664. Monsieur Le Febure presented his printed discourse, both in French and English, upon the preparation of Sir Walter Raleigh's cordial. He likewise read a Latin letter sent him from Paris, and signed for attestation by some of the principal physicians and chirurgeons of that city, concerning the art practised by one Monsieur Bienaise, of healing tendons and nerves transversely cut, so as to restore the patient to the full use of his limbs. He was desired to leave the letter with the society, which he promised to do, after he had shewn to some of the college of physicians.

November 25, 1663. The president acquainted the society, that he had received a letter sent to a minister in England from a suffragan bishop in Iceland; which letter being produced, the secretary was ordered to peruse it, and give an account of it to the society at their next meeting; against which time the amanuensis was ordered to make a copy of the inquiries formerly drawn up by Mr. Hooke and sent to Iceland, in order that they might be considered of, and fitted by the president to be sent and recommended to the said bishop, as a person conceived to be capable and curious enough to return a proper answer to them.

November 26, 1662. The lord viscount Brouncker acquainted the Society with the approach of St. Andrew's day; and that by reason of the necessity of making some alterations in their charter, there could not be conveniently made an election of new council this year: but it was offered to the Society, whether they would propose some other persons to be presented to the King, and, according to his majesty's pleasure, to be put into the council of the altered patent, instead of some of those, who were in the first. It was put to the question, whether any alteration should be made in the council, or not? and it was carried in the negative.—Dr. Wilkins showed his way-wiser, and the effects thereof upon a coach; and was desired to leave his first engine of this kind with the society.

November 28, 1666. Mr. Henry Howard [afterwards Duke of Norfolk] was elected and admitted, who also received the public thanks of the Society for his respects to them.—Dr. Wallis gave the society some account of what he had lately observed in Kent about tides, viz., that, according to his hypothesis, the tides had been very high about Romney-marsh, three days after the new moon; which though the seamen there ascribed to the high winds, as not thinking of any other cause, yet he thought it might be imputed to the cause assigned in his theory; especially if upon continued observations for several years together it should happen in the same manner.

1667. Mr. Coga, the first person in England, on whom the experiment of transfusion was made by order of the Society, and by the management of Dr. Lower and Dr. King, presented himself before the Society, and produced a Latin paper of his own, giving an account of what he had observed in himself since he underwent the said experiment. It was ordered likewise that Mr. Coga being willing to have the experiment repeated on him, it should be tried again accordingly, when the physicians of the Society should judge it seasonable. [Oldenburg in a letter to Boyle, takes notice that the experiment was performed at Arundel-house, in the presence of many spectators, including Mr. Henry Howard and both his sons. The morning after the lord viscount Brouncker and Mr. Oldenburg went to see Mr. Coga pretty early.]

Societies and Academies.

LONDON.

Royal Society, November 13.—Sir Arthur **Schuster**: On the total reflection of light. The light which enters the optically rarer medium at or beyond the critical angle is an effect of diffraction originating near the boundary of the refracting surface. It derives its energy from the incident beam and must diminish the intensity of the reflected light. Thus there can be no total reflection in the strict sense of the word. The ratio of the energy dissipated by diffraction to the total energy of the incident light is inversely proportional to the length of the refracting surface, and therefore tends towards zero as the size of the refracting surface increases. At the critical angle the light dissipated by diffraction amounts to about one per cent. of the incident light, when the length of the refracting surface is 5 cm. The numerical value is subject to correction depending on the approximate nature of the investigation.—N. K. **Adam** and J. W. W. **Dyer**: The molecular structure of thin films. Pt. VI. Five long-chain alcohols have been examined. The area of cross-section of the chain in the alcohols is the same as in the acids, within 2½ per cent., and the CH_2OH group occupies 21·6 sq. A.U. of area. The acetates of these alcohols pack with the heads occupying 23 sq. A.U., and form expanded films of the same kind as other esters. The methyl ethers of the alcohols do not form stable films. Highly unsaturated acids, with three and five double bonds in the chains, behave much like oleic acid, which only has one double bond. Arachidic acid and its derivatives behave normally. Substituted acetamides show a solid film with chains close-packed at low temperatures, and this melts at a definite temperature, raised by compression, to a liquid film of area 24·2 sq. A.U. This melting seems to be due to the molecules acquiring sufficient kinetic energy other than translational to break up the solid structure. Hydrocarbon chains more than 27 carbons long tend to mask the typical phenomena in condensed films. Pentærythritol tetrapalmitate, which has four chains attached to a common centre through polar groups, and should normally have these four chains directed to the corners of a tetrahedron, orients all the chains vertically in the surface. These are not quite close-packed until a compression of about 20 dynes per centimetre is applied.—T. **Alty**: The cataphoresis of gas bubbles in water. The velocity of a gas bubble in water is independent of the gas used. It is proportional to the applied field throughout the whole range of diameters, the maximum velocity being $4{\cdot}1 \times 10^{-4}$ cm./sec./volt/cm. at a diameter of about 0·1 mm. The highest velocity is only attained in water of specific conductivity $8{\cdot}5 \times 10^{-6}$ ohms^{-1}. In water of specific conductivity $1{\cdot}8 \times 10^{-6}$ ohms^{-1}, the charge on the bubble is very small, and is occasionally reversed during the course of an experiment. Two bubbles appear to repel each other.—D. R. **Hartree**: Some relations between the optical spectra of different atoms of the same electron structure. I.—Lithium-like and sodium-like atoms. Relations between values of corresponding terms of the spectra of different atoms of the same electron structure are worked out for the Bohr atom model with a central field. The relations are different according as the series electron does or does not penetrate into the core. The theoretical relations agree fairly closely with such experimental data as are available.—P. A. M. **Dirac**: The conditions for statistical equilibrium between atoms, electrons and radiation. The principle that every process which

occurs in an assembly in thermodynamic equilibrium is exactly balanced by the reverse process occurring to the same extent is applied to the general case of n-body encounters, both radiative and non-radiative processes being considered. Van 't Hoff's isochore is of universal validity, even for radiative processes and with relativity mechanics. From Planck's law of radiation it is deduced that every process by which radiation is emitted is stimulated by external radiation of the same frequency, the ratio of stimulated to spontaneous emission being independent of the nature of the process, and inversely proportional to the cube of the frequency.—Ida **Doubleday**: Boundary lubrication—further consideration of the influence of the composition of the solid face.—Christina C. **Miller**: The Stokes-Einstein law for diffusion in solution. Dilute solutions of iodine in a large number of solvents of different viscosity were used. According to the Einstein-Stokes expression, which is based on the assumption of large particles moving amongst relatively small molecules, the product [diffusion-coefficient × velocity] should be constant for all solvents. The product in the case of organic solvents actually varied between 850 and 1544; for aqueous solutions of alkali halide of different concentrations the variation was between 826 and 1216. According to Sutherland, on the opposite assumption that small dissolved molecules move amongst relatively large molecules, the value of the product in the extreme case should be 1·5 times as great as the value given by the Einstein-Stokes expression. If acetylene tetrabromide be excepted, the ratio for any two products actually falls between 1 and 1·5.—Helen S. **French** and T. M. **Lowry**: Studies of co-ordination, Pt. I. Absorption spectra and co-ordination of some cupric compounds. The absorption-spectra of the cupric compounds, both organic and inorganic, are dominated by (i.) a red or infra-red band, which is characteristic of the cupric atom, and (ii.) an ultra-violet band or general absorption, which depends mainly on the anion or organic radical. The colour of the cupric compounds depends on the character of the narrow region of transmission between these two absorptions.—L. F. **Bates**: On the range of α-particles in rare gases. A scintillation method was used, and the value found for helium, after repeated purification of the gas used, is very different from that found by previous observers, due probably to the big effect of small quantities of impurities in reducing the range. Henderson's theory of the loss of energy of an α-ray in passing through matter, whilst accounting for approximately the same fractional loss of energy in all the rare gases, does not account for the whole loss. There is a rough linear relation between the logarithms of the observed stopping powers and the logarithms of the atomic weights of the rare gases, but it does not take the simple form given by Bragg and Kleeman. —D. H. **Black**: The β-ray spectrum of mesothorium 2. Thirty-one lines were detected and their energies calculated. The majority of these lines are considered to be due to the conversion of γ-rays in the absorption levels of the atom itself. In all, eight γ-rays have been classified, and it has been possible to account for seven of these quite satisfactorily by the system of transitions between levels in the nucleus. —J. Keith **Roberts**: The thermal expansion of crystals of metallic bismuth. The thermal expansion of crystals of metallic bismuth parallel and perpendicular to the vertical axis, by comparison with that of crystalline quartz, are practically constant from ordinary temperatures up to 240° C. Bismuth melts at about 270° C. The constant expansion coefficients over this range are:—Perpendicular to the axis, $12{\cdot}0 \times 10^{-6}$; parallel to the axis, $16{\cdot}2 \times 10^{-6}$; mean, $13{\cdot}4 \times 10^{-6}$. The bending over of the length-temperature curve as the melting-point is approached indicates dissociation of the atoms in the solid.—R. **Stoneley**: Elastic waves at the surface of separation of two solids. A wave, analogous to the Rayleigh wave, exists at the plane surface of separation of two elastic solids, which extend otherwise to infinity, if the velocities of distortional waves in the two media are nearly equal. A transverse wave of the type that Prof. Love has shown to exist in certain circumstances in a surface layer cannot exist at this surface of separation. A wave of this type may exist in a stratum of uniform thickness bounded by media extending to infinity if the stratum is sufficiently thick or the wave-length sufficiently small. Nodal planes may also exist. The geophysical bearing of these results is that some of the energy of deep-seated earthquakes may be "trapped" at surfaces of discontinuity, and eventually be dissipated in solid friction without appreciably affecting seismographs. —J. H. **Jones** and J. C. **Boyce**: The constants of the Rydberg-Ritz equation. The type of atomic field necessary to give observed terms in hydrogen-like spectra must be due to a virtual attracting charge which is additional to the net charge of the atomic kernel. The additional field, strong near the kernel, but rapidly diminishing at greater distances, resembles that of an electric doublet. The doublet seems to be induced in the kernel by the field of the valence electron itself, in its interaction with the screening electrons. This can be pictured as the charge induced on a conducting sphere, and for such a model a Ritz spectral formula may be derived. One of the correcting terms of the Ritz formula has been obtained for a number of spectra of the sodium type, and the values are of the same order of magnitude as those calculated from known spectral data.

Physical Society, October 24.—Mr. F. E. Smith in the chair.—D. **Gunnaiya** and G. **Subrahmaniam**: Underblown pipes. The phenomena of underblown pipes have been studied in the case of four wooden pipes ranging over an octave. They present many features of remarkable interest, and a new theory is proposed.—W. **Mandell** and J. **West**: On the temperature gradient in gases at various pressures. Sets of curves indicating these gradients at various pressures have been obtained; they show the existence in contact with the vessel walls—at low pressures—of very large "temperature jumps." The general character of the results may be explained on the assumption of the presence at the walls, of a gas film possessing certain properties due to the attracting forces existing amongst wall molecules and gas molecules. Several thermocouples of differing thicknesses—and therefore differing curvature—were employed under identical conditions. They showed systematic differences which may also be attributed to the presence round the various thermocouples of gas films the thickness and character of which vary with the thickness of the couple.—J. F. S. **Ross**: Vectorial dimensions: The paper directs attention to the deficiency of the present dimensional notation [M] [L] [T], and in particular to the anomalies (*a*) that it makes the dimensions of work and torque the same, and (*b*) that it allows the dimensions of angular velocity and acceleration to appear as functions of time alone. These defects are due to the neglect of the vectorial character of length, and it is accordingly proposed that the present notation be modified by using the symbols $[L_x]$, $[L_y]$, and $[L_z]$, where different directions are involved. The proposal by Bartorelli to treat angle as a fourth independent fundamental quantity is open to serious criticism.

Mineralogical Society, November 4.—Dr. H. H. Thomas and afterwards Prof. W. W. Watts in the chair.—M. S. **Krishnan**: Note on cordierite in a cordierite-gneiss from Madura District, Madras, India. Optically positive cordierite occurs in an Archæan gneiss produced by the metamorphism of biotite-gneiss by an intrusive tongue of charnockite. The associated rocks are crystalline limestones (with lime-silicate minerals), and gneisses containing felspars, garnet, sillimanite, biotite, and titanoferrite. Cordierite from two other localities in Peninsular India (Vizagapatam and Travancore) is also known to be optically positive. This positive character is suggested to be due to the isomorphous replacement of MgO by FeO, as in the rhombic pyroxenes, olivines, etc.—A. **Brammall**: Lime as a constituent of certain important rock-forming minerals: its behaviour relative to that of other bases of RO type. A review of the facts governing the extent to which RO-bases replace each other in rock-forming minerals, special reference being made to the antipathetic relationship between lime and magnesia as constituents of the same simple molecule.—L. J. **Spencer**: (1) An inclusion of magnetite in diamond. A minute black fragment (about 1 mg.) taken from a cavity in a diamond from Bultfontein mine, Kimberley, was definitely identified as magnetite. Black inclusions and spots are of common occurrence in diamond, but usually they are non-magnetic and therefore not magnetite. (2) Biographical notices of mineralogists recently deceased (second series). Notices of fifty-five English and foreign mineralogists. The average age of 303 lives (since 1876) is 64 years, and a curve shows a highest point at 74 years. The greatest age was attained by F. E. Neumann (1798–1895), the German crystallographer.—A. **Russell**: A notice of the occurrence of native arsenic in Cornwall (with analysis by H. F. Harwood); of bismuthinite at Shap, Westmorland; and of smaltite and niccolite at the Coniston Mine, Lancashire.

MANCHESTER.

Literary and Philosophical Society, November 4.—H. B. **Dixon** and W. F. **Higgins**: On the phosphorescent flame of carbon di-sulphide. In determining the ignition-point of mixtures of carbon disulphide vapour with other gases, *e.g.* hydrogen, nitrogen, carbon dioxide, methane, it was found that a mixture of 80 per cent. methane with 20 per cent. carbon disulphide immediately inflamed when brought into oxygen in a concentric-tube apparatus at a temperature of 191° C., but did not inflame in air until both gas and air were heated to above 410° and had been in contact 10 seconds. The mixture of methane and carbon disulphide was observed to give a phosphorescent glow when it met the air at temperatures between 200° and 400°, and by regulating the gas supply a steady flame could be maintained. This flame can be studied more easily in a glass tube, or by throwing a steady air current by means of a glass cone on to the gas jet. The phosphorescent flame is due to the partial burning of the carbon disulphide, to carbon mono-sulphide, and sulphur dioxide. The methane is not attacked. The flame does not come down to the jet: it lights some inches above it. When certain gases, such as ethylene, acetylene, coal-gas, nitrogen peroxide, mix with the gas and air near the orifice of the jet, the phosphorescent flame is immediately extinguished—but these "poison" gases have no effect when brought into the flame itself. The phosphorescent flame is accompanied by particles of the red-brown polymer of CS and appears to be due to the partial burning of CS_2 molecules condensed on these solid particles. The "poison" appears to prevent this condensation.

PARIS.

Academy of Sciences, October 27.—M. Guillaume Bigourdan in the chair.—The president announced the death of Louis Emile Bertin, the oldest member of the section of geography and navigation, past-president of the Academy.—Paul **Appell**: The nature of the movement of a fluid celestial body round its centre of gravity.—G. **Friedel**: An experiment demonstrating the symmetry between the increase and decrease of crystals.—Édouard **Imbeaux**: The great artesian basins of the United States.—Paul **Montel**: The exceptional involutions of the algebroid functions.—Maurice **Fréchet**: An intrinsic parametric representation of the most general continuous curve.—S. **Stoïlow**: The continued transformations of a variable.—Alfred **Rosenblatt**: Varieties of three dimensions the tangent spaces of which satisfy certain differential equations.—R. **Jacques**: Networks such that the congruences described by the tangents and the congruences derived by the Laplace method belong alternately to linear complexes.—Jean **Thibaud**: The absorption and diffusion of γ-rays of very great energy in the light elements.—A. **Dauvillier**: A method of distinguishing natural pearls from culture pearls. The means hitherto available for distinguishing between the pearls produced artificially in the oyster by the Japanese method and natural pearls, necessitate the destruction of the pearl. It is shown that the photographs of the Laue figures produced by X-rays are different for the two classes of pearl, and this examination does not require the mutilation of the pearl.—Jules **Stoklasa** and Jos. **Penkava**: The radioactivity of the eruptive gases of Vesuvius and of solfataras and their influence on the development of bacteria and the higher plants. Details of measurements of the electrical conductivity of the air near two craters of Vesuvius, at different altitudes on the Eiffel Tower in Paris, and at the potash mines at Mulhouse.—L. J. **Simon**: The neutralisation of chloric acid by the alkalis, followed by means of viscosimetry. The minimum viscosity corresponds to equimolecular proportions of alkali and acid.—E. **Audibert**: A necessary condition for safe mining in an inflammable atmosphere. Doubt is thrown on the efficacity of inert rock dust for preventing the propagation of explosion in mines.—A. **Lassieur**: The electrolytic separation of copper, antimony, lead and tin.—A. **Damiens**: The suboxide of tellurium. The experiments described do not confirm the production of tellurium suboxide under the conditions given by Divers and Shimozé. The reaction indicated by them is incomplete when working with pure tellurium, and the body described as the suboxide TeO is only a mixture of tellurium and the dioxide TeO_2.—J. A. **Muller** and Mlle. E. **Peytral**: The sudden pyrogenic decomposition of methyl formate and the principle of minimum molecular deformation. Methyl formate, passed rapidly through a hot tube at 1000° C., splits up into two molecules of formaldehyde; secondary decomposition of the aldehyde gives rise to carbon monoxide and hydrogen.—J. **Barthoux**: Contact metamorphism in the Djebilet ad Rehamna, Morocco.—Sabba **Stefanescu**: The apparent anomalies of the molars of elephants and the number of plates of their crowns.—A. **Maige**: The regeneration of the amylogen excitability of the plasts during hydrolysis.—L. **Leger**: The specific value of the three kinds of European lamprey and the young stages of *Petromyzon fluviatilis*. From a study of the young post-larval stages, the author concludes that the three kinds of European

lamprey, known under the names of *Petromyzon marinus*, *P. fluviatilis*, and *P. planeri*, must be considered as distinct species, since their differential characters, clearly marked in the adult, are already shown from the metamorphosis which follows their long larval life in fresh water.—M. **Parat** and J. **Painlevé**: The internal reticular apparatus of Golgi, Holmgren trophosponge and vacuome. The "reticular apparatus" of Golgi or the "trophosponge" of Holmgren results from the precipitation of metallic silver or osmium in the interior, at the periphery, or in the interspaces of the protoplasmic vacuoles. The author concludes that there is no cellular "apparatus."—A. **Bonnet**: The digestive and absorbing apparatus of some Echinideæ.—Eugène **Aubel** and René **Wurmser**: The utilisation of the energy liberated by oxidations.

BRUSSELS.

Royal Academy of Belgium, May 6.—M. Max Lohest in the chair.—Report on the work of the Committee on "Biographie Nationale" during the year 1923-1924.

June 7.—M. Max Lohest in the chair.—The P. J. and Ed. van Beneden Prize (2nd period, 1921-1923) is awarded to M. Daleg for his researches on the physiology of the egg during maturation: the decennial prize for applied mathematics (period 1913-1922) to M. De Donder for his works on the Einstein gravific and his treatises on thermodynamics and physical chemistry.

August 2.—M. Max Lohest in the chair.—The Edouard Mailly Prize is awarded to the Antwerp Astronomical Society.—Th. De **Donder**: The Weyl-Eddington-Einstein gravific.—Victor van **Straelen**: An amphipod from the oil-bearing strata of Pechelbronn (Alsace). Details of a new species to which the name of *Gammarus alsaticus* is given.—M. **Alliaume**: The best approximation in the determination of the instantaneous terrestrial pole and an attempt at the systemisation of researches on the deviation from the vertical.—M. **Alliaume**: The generalisation of Poisson's theorem relating to the probability of an event the cause of which has undergone an unknown modification.—R. **Lucion** and A. **Brichaux**: Experiments undertaken by Ernest Solvay, from 1877 to 1881, on the fundamental unity of matter and energy.—E. **Ectors**: Contribution to the study of the reaction of organo-magnesium compounds on the nitriles. Benzonitrile. An account of experiments made to elucidate the mechanism of the reaction between benzonitrile and benzylmagnesium chloride.—Suzanne **Leclercq**: New observations on the anatomical structure of some fossil plants of the Belgian coal measures. Two new species are described, *Botryopteris Fraiponti* and *Sphenophyllum Gilkinetti*.—A. **Merten**: The calculation of barrage walls.—Victor van **Straelen**: The first remains of fossil Phacochoerus collected in the Belgian Congo.—J. de **Smedt**: The diffraction of the X-rays by polymerised liquids.

DUBLIN.

Royal Dublin Society, October 28.—Prof. E. A. Werner in the chair.—H. H. **Jeffcott**: The determination of the most economic size of pipe line for water-power installations. In choosing the size of pipe lines and tunnels leading from a reservoir to the turbines in a hydroelectric installation, the criterion of greatest economy is that the sum of all the charges in connexion with the pipe lines (including the value of the power lost in the pipes), when reckoned over a long period of years, shall be a minimum. Reducing the diameter of such pipe line lessens cost, but increases the loss of power due to frictional resistance, and, owing to loss of head at peak loads, it is necessary either to increase the size of the turbines, or to install additional turbine and generator sets to supply the deficiency at large discharge. From these considerations formulæ are obtained for the theoretically best sizes. As practical considerations require the thickness of wall of the pipe to be not less than a specified quantity, the low-pressure portion of the pipe line is of constant size. Thereafter the diameter diminishes, and the thickness of wall increases gradually as the pipe line descends towards the power-house. For the tunnel portion of the system the diameter is constant under the conditions hypothesised. As the output of the power-station varies considerably from time to time, the total frictional loss of energy in the pipe line in a year is proportional to the mean cube of the several discharge rates during equal periods in that year.—W. R. G. **Atkins** and G. T. **Harris**: Seasonal changes in the water and heleoplankton of freshwater ponds. The plankton of two ponds was found to be very different, so the water was analysed and the plankton estimated at intervals for about two years. A new record was obtained for *Elakatothrix gelatinosa*. The electrical conductivity of the water was low when the P_H value was high; the seasonal changes differed in the two ponds. In spring the developing plankton used up all the phosphate, lack of which appeared to limit the increase in growth.—K. C. **Bailey**: The synthesis of urea from carbon dioxide and ammonia under atmospheric pressure. Urea can be synthesised from carbon dioxide and ammonia at atmospheric pressure by passing the mixed gases through the annular space between a quartz tube heated to a temperature higher than 500° C. and an inner water-cooled glass tube. It is advantageous to use the gases in the ratio of two volumes of ammonia to eight of carbon dioxide. The yield of urea increases with temperature to at least 700°.

Royal Irish Academy, November 10.—Prof. Sydney Young, president, in the chair.—K. C. **Bailey**: The reaction between ferric chloride and potassium thiocyanate. The reaction between ferric chloride and potassium thiocyanate in various proportions has been reinvestigated, and an explanation is offered of the seeming anomalies in the extraction of ferric thiocyanate by ether or amyl alcohol. No evidence has been found of the existence in the reaction mixture of a dithiocyanate.—K. C. **Bailey** and J. D. **Kidd**: Freezing-points of solutions containing ferric chloride and potassium thiocyanate. Freezing-point curves of solutions containing ferric chloride and potassium thiocyanate in varying proportions have been constructed, but no definite evidence was obtained of the formation of double compounds.

Official Publications Received.

Bulletin of the American Museum of Natural History. Vol. 50, Art. 5: Further Notes on Ptilosis. By W. de W. Miller. Pp. 305-331. (New York City.)

Department of Health, Canada. Publication No. 32: Small-Pox and Vaccination; a Popular Treatise. By Dr. J. J. Heagerty. Pp. 27. (Ottawa: Department of Health.)

Union of South Africa: Department of Agriculture. Science Bulletin No. 32 (Division of Chemistry Series No. 33): The Composition of Ripe Wine Grapes from the Government Viticultural Station, Paarl. By G. Frater. Pp. 30. (Pretoria: Government Printing and Stationery Office.) 3*d*.

Canada. Department of Mines: Mines Branch. Bituminous Sands of Northern Alberta. By Sidney C. Ellis. Pp. 35+6 plates. (Ottawa: F. A. Acland.) 25 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 291: A Gravimetric Test of the "Roots of Mountains" Theory. By William Bowie. Pp. 8. (Washington: Government Printing Office.)

United States Department of Agriculture. Department Bulletin 1227: Damage to Range Grasses by the Zuni Prairie Dog. By Walter P. Taylor and J. V. G. Loftfield. Pp. 16+6 plates. 10 cents. Department Bulletin No. 1267: The Rough-headed Corn Stalk-beetle. By W. J. Phillips and Henry Fox. Pp. 34. 10 cents. Department Bulletin No. 1268: Returns from Banded Birds, 1920 to 1923. By Frederick C. Lincoln. Pp. 56+4 plates. 10 cents. Department Bulletin No. 1273: The Bud Moth. By B. A. Porter. Pp. 20. n.p. (Washington: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 8: Visual Education Departments in Educational Institutions. By A. P. Hollis. Pp. iii+36. Bulletin, 1924, No. 15: The Daily Schedule in the High School. By J. B. Edmonson, Warren E. Bow, Irvin Van Tassell. Pp. ii+17. (Washington: Government Printing Office.) 5 cents each.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Vincent, for the Year 1923. Pp. iv+50. (Trinidad.) 6*d*.

Transactions and Proceedings of the Botanical Society of Edinburgh. Vol. 29, Part 1, Session 1923–24. Pp. viii+118+5 plates. (Edinburgh.) 7*s*. 6*d*.

República Argentina. Ministerio de Agricultura de la Nación: Oficina Meteorologica Nacional. Boletin Mensual. Año 5, 1920. Pp. 89+12 charts+51 maps. (Buenos Aires.)

New Zealand Department of Mines: Geological Survey Branch. Bulletin No. 26 (New Series): The Geology and Mines of the Waihi District, Hauraki Goldfield, New Zealand. By P. G. Morgan. Pp. ix +218+7 plates. (Wellington, N.Z.: W. A. G. Skinner). 10*s*.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 270: Geodetic Operations in the United States and Outlying Possessions, January 1, 1922, to December 31, 1923. By William Bowie. (Special Publication No. 104.) Pp. iv+28+18 plates. (Washington: Government Printing Office.)

Quarterly Journal of the Royal Meteorological Society. Edited by a Committee of the Council. Vol. 50, No. 212, October. Pp. 277-397+viii. (London: E. Stanford, Ltd.) 7*s*. 6*d*.

Tide Tables for the Pacific Coast of Canada for the Year 1925: including Fuca Strait, the Strait of Georgia, and the Northern Coast; with Data for Slack Water in the Navigable Passes and Narrows and Information on Currents. Issued by the Tidal and Current Survey in the Department of Marine and Fisheries of the Dominion of Canada. (Twenty-fifth Year of Issue.) Pp. 72. (Ottawa: F. A. Acland.) Gratis.

Tide Tables for the Eastern Coasts of Canada for the Year 1925: including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits; and Information on Currents. Issued by the Tidal and Current Survey in the Department of Marine and Fisheries of the Dominion of Canada. (Twenty-ninth Year of Issue.) Pp. 76. (Ottawa: F. A. Acland.) Gratis.

Development Commission. Fourteenth Report of the Development Commissioners for the Year ended the 31st March 1924. Pp. 156. (London: H.M. Stationery Office.) 4*s*. net.

Diary of Societies.

MONDAY, NOVEMBER 24.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory), at 4.30.—C. T. R. Wilson: Acceleration of β-Particles in Strong Electric Fields such as those of Thunderclouds.—Dr. G. F. C. Searle: The Determination of the Frequency of an Alternating Current Supply by the Vibrations of Rods.—Dr. F. W. Aston: Photographic Plates for the Detection of Mass Rays.—E. B. Moullin: The Current induced in a Wireless Telegraph Receiving Antenna.—R. R. S. Cox: Note on the Chemical Constant of Chlorine.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. T. J. Jehu and R. M. Craig: Geology of the Outer Hebrides, Part 2. South Uist and Eriskay.—J. A. Eldridge: Note on Professor Whittaker's Atomic Model.—W. Saddler: The Irreducible System of Concomitants of Two Double Binary (2,1) Forms.—A. C. Aitken: A Series Formula for the Roots of Algebraic and Transcendental Equations.—Prof. J. Tait and Dr. W. F. Emmons: Experiments and Observations on Crustacea. Part VI. The Mechanism of Massive Movement of the Operculum of *Balanus nubilis*.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—N. A. Allen and others: Discussion on The Electrostatic Wattmeter used for measuring Dielectric Losses in Cables.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.

ROYAL SOCIETY OF ARTS, at 8.—Dr. L. C. Martin: Modern Colour Problems (1) (Cantor Lectures).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—G. J. Goldie and Prof. Collingwood: Note on Protagulin in Hæmorrhage after Extraction.

MEDICAL SOCIETY OF LONDON, at 8.30.—Sir Anthony Bowlby, Bart., and others: Discussion on The Treatment of Senile Gangrene.

TUESDAY, NOVEMBER 25.

ROYAL DUBLIN SOCIETY (at Royal College of Surgeons, Dublin), at 4.15.—Miss S. D. King: Oogenesis in *Lithobius forficatus*.—Rev. H. C. Browne: The Influence of the FitzGerald Contraction on Space Measurements and Clock Times.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Lord Stevenson: British Empire Exhibition.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—D. L. Thornton: The Rôle of Technical Training in Marine Engineering.

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at 83 Pall Mall), at 7.—Demonstration and Discussion on Car-cleaning Devices.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—G. Rogers: Automatic and Semi-automatic Rectifier Sub-stations.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. R. Newens: With Camera and Colour Plate.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates Section) (at Broadgate Café, Coventry), at 7.15.—W. W. Small: Body Building.

ROYAL ANTHROPOLOGICAL INSTITUTE (at Royal Society), at 8.30.—P. Rêné Verneau: La Race de Néanderthal et la Race de Grimaldi: Le rôle dans l'humanité (Huxley Memorial Lecture).

WEDNESDAY, NOVEMBER 26.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Section) at 244 Deansgate, Manchester), at 6.30.—Mr. Martin: Automobile Coa building.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbu Crescent, Glasgow), at 7.—Ex-Bailie W. B. Smith: The Future Prosp of a Clean Atmosphere.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section) (joi with Institution of Structural Engineers), at 7.30.—J. E. Barna The Elementary Principles of Microscopical Illumination (2). S Luminous Objects.—H. J. Deane: The Application of Microscopy Cement Research.

ROYAL SOCIETY OF ARTS, at 8.—C. F. Elwell: Talking Motion Picture

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society Medicine), at 8.30.—Dr. D. E. Core: The Clinical Value of Cert Emotions.

THURSDAY, NOVEMBER 27.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), 4.30.—Dr. W. Edgecombe: The Principles of Spa Treatment in Gr Britain (Presidential Address).

ROYAL AERONAUTICAL SOCIETY, at 5.30.—Dr. G. C. Simpson: Thund storms.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. J. Findlay: Education and Rhythm.

INSTITUTION OF AUTOMOBILE ENGINEERS (Luton Graduates Meeting) Luton), at 7.30.—G. D. Ricketts: Production.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section, jointly wi Society of Dyers and Colourists) (at University College, Nottingham) G. H. Ellis: Acetate Silk.

FRIDAY, NOVEMBER 28.

PHYSICAL SOCIETY OF LONDON (jointly with Royal Meteorological Socie (at Imperial College of Science), at 5.—Discussion on The Ionisati of the Atmosphere, and its Influence on the Propagation of Wirel Signals.—Dr. W. H. Eccles: Opening Address.—Dr. C. Chree: Atm spheric Ionisation and its Variations.—Prof. E. V. Appleton: Expe mental Observation of the Strength of Wireless Signals as affected the Path of the Signals, Time of Day, and Season of Year.—R. Watson Watt: Atmospherics.—C. T. R. Wilson: The Electric Fie of a Thundercloud and some of its Effects.—Prof. S. Chapman: T Evidence of Terrestrial Magnetism for the Existence of Highly Ionis Layers in the Upper Atmosphere.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), 5.30.—Discussion and Demonstration on The After-treatment of Medic Diseases of Joints.

JUNIOR INSTITUTION OF ENGINEERS, at 6.30.—Exhibition of late Scientific Instruments and Appliances for the use of Engineers.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Capt. C. W. Knight: Bird Life from an Observation Post.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDE (at Literary and Philosophical Society, Newcastle-on-Tyne), at 7.30. J. Tutin: The Prediction of Critical Speeds in Ship Resistance.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDE (Middlesbrough Branch) (at Cleveland Scientific and Technical Instit tion, Middlesbrough), at 7.30.—H. G. Clement: Ships' Life-Savi Appliances.

INSTITUTION OF MECHANICAL ENGINEERS (Sheffield Section) (at Sheffield —Prof. F. C. Lea: Effect of Repetition Stresses on Steels.

SATURDAY, NOVEMBER 29.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDE (Graduate Section, jointly with North of England Institute of Minir and Mining Engineers) (at Neville Hall, Newcastle-on-Tyne), at 3.

ROYAL IRISH ACADEMY, at 4.15.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 22.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: Soci Life amongst Insects. II. Butterflies and Moths.

TUESDAY, NOVEMBER 25.

WESTFIELD COLLEGE, HAMPSTEAD, at 5.15.—Rev. Dr. W. B. Selbie Psychology and Religion.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: Bosanquet's Theor of the State and Society.

WEDNESDAY, NOVEMBER 26.

INSTITUTE OF HYGIENE, at 3.30.—Dr. H. G. Anderson: The Prevention o Physical Deformities.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Prof. W. Cullis: The Practic of Health.

MEDICAL SOCIETY OF LONDON, at 5.15.—Dr. W. M. Feldman: Ante-Nata Child Physiology and Hygiene (Chadwick Lecture).

UNIVERSITY COLLEGE, at 5.30.—A. Esdaile: The British Museu Library. II. The Collections.

THURSDAY, NOVEMBER 27.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Prof. Neilson Jones: Dua Personality in Plants.

KING'S COLLEGE, at 5.30.—O. V. Salomón: The Modern Civilisation o Peru.

UNIVERSITY COLLEGE, at 5.30.—Prof. E. G. Gardner: The Personality o Mazzini.

FRIDAY, NOVEMBER 28.

KING'S COLLEGE, at 5.30.—Prof. E. W. MacBride: Scientific Method.

SATURDAY, NOVEMBER 29.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—S. H. Warren: Prehistori Man and the "Land of Lyonesse."

NATURE

SATURDAY, NOVEMBER 29, 1924.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2874, VOL. 114]

The Boxer Indemnity and Chinese Education.

IF it were not for the remarkable powers of recuperation which China has shown on more than one occasion after an apparently crushing disaster, present conditions in that country would appear to afford anything but an opportune moment for discussion of the possibilities of reform and regeneration. An enormous number of her population, estimated at thirty millions, has been rendered destitute by floods, and the country is in the throes of civil war between rival provincial governors. Yet the situation is not entirely without hope. China, for better or for worse, has adopted the form of Western institutions of government. Whatever may be the outcome of the present struggle, which represents on one side an attempt to secure unity with strong central control by force, the future of the country will depend upon how far the Chinese are enabled to assimilate the spirit of Western culture, without which superficial measures of reform may well be a delusion and a disaster. A wise use of the Boxer indemnity, which is to be remitted from the year 1922, would play a paramount part in shaping the course of events. The size, the vastness of the resources, and the immense numbers of the population of China, make the question of her future development of vital and world-wide interest. It is unnecessary to emphasise here the importance of China as a centre of production in relation to world supply, both now and still more in the future. The fact alone that two hundred thousand foreigners are resident in the country, for the most part interested in some form of industry or commerce, makes good government and the stability of the country a matter of immediate concern to the nations to which they belong, while it is no longer possible that a state of unrest in almost any country, however remote, can for any length of time fail to affect other parts of the world.

Without going into detail, it may be useful to recapitulate briefly the present position of the Boxer indemnity so far as Great Britain is concerned. In 1922 it was decided by the Government then in power to remit the balance of the indemnity due from China to Great Britain on account of the Boxer Rising in 1900. The indemnity was payable over a term of years which had been extended to 1945. The payments affected thus cover a period of twenty-three years, the amount payable being 400,000*l.* per annum, representing a capital sum of approximately 11,000,000*l.* The remission, however, was not absolute: the amount due is still to be collected from various sources of Chinese revenue; but instead of being paid into the Sinking Fund, it is to be devoted to objects beneficial to both

countries. A Bill to give effect to this decision was introduced into Parliament in May of this year, but has still to be passed by the legislature.

It is scarcely necessary to enter into the reasons which led to this course of action on the part of the British Government; nor indeed have they ever been fully stated. One consideration which no doubt carried great weight was the fact that of the powers interested, two—the United States and Japan—had already remitted their indemnities on conditions. Great Britain could not have stood aside without damage to her prestige. France also, without remitting her payments, has devoted them to liquidating the affairs of a French bank in China of which the depositors were mainly Chinese. The claims of Germany, the largest participant, were cancelled during the War. Payments to Russia ceased after the collapse of that country, but, by arrangement between China and the Soviet Government, the whole of the Russian indemnity, arrears and future payments alike, is to be devoted to "promotion of education among the Chinese people."

Misappropriation of the funds made available by the cancellation of the obligation to Germany, has served as a warning to those powers which were prepared for remission. They desired to act for the benefit of China; but it was clear that in the disturbed condition of the country which has prevailed since the reform movement of 1911, a strong hand was needed to secure that the people as a whole would profit by the advantages which should accrue from a judicious expenditure of the amount thus made available.

In the Bill introduced into Parliament it was stated, following the announcement on remission made in December 1922, that the amounts receivable from the indemnity fund were to be expended upon objects beneficial to both countries. Various suggestions have been put forward to give precision to this vague phrase. Deputations have urged that the money should be expended on public works under British supervision. Another suggestion was that a Science Museum should be instituted at Peking. In favour of the latter proposal there is little to be said. Even if the country were sufficiently advanced to reap the full benefit of such an institution, difficulties of communication and transport would militate against the free and extended use which alone would justify such a disposal of the funds. The benefit would be confined to Peking. For the former, the proposal to devote the money to public works, there is more to be said, but here again the amount is so small relatively to the size of the country, that in the end it could do little more than benefit one or two more or less restricted areas. Nor is appropriation for this purpose by any means such an urgent need as it has been attempted to make out.

If a broad view of the situation be taken, there ca be no two opinions that both the needs of China an the wishes of the Chinese themselves point unmistak ably in one direction, and that is education. This vie has, at any rate, commended itself to the two powe which have already remitted the indemnity. In eac case the funds are to be made available for educatio It was at the suggestion of the Chinese themselves tha the Russian indemnity has been devoted to this purpos Among British residents in China, those who are mos competent to speak with authority, namely, the repre sentatives of the British Chambers of Commerce, hav been most emphatic in urging the claims of educatio Further, they have insisted that the situation calls fo education on British lines. Thereby they hope tha something of the British public school spirit may b introduced into Chinese education.

While the Chinese are endowed with many admirabl qualities, in which those who know them best can se much that is closely akin to ourselves, they have man weaknesses which are no doubt due to the isolation i which their civilisation developed. Among them mus be reckoned a too restricted view of their obligations an duties as citizens, arising from their intense preoccupa tion with the claims of the family group. To this mus be attributed many of the defects of their governmen and public life, while, coupled with their distrust o foreigners, it has been responsible for their failur in their international relations both in peace an in war. Without any desire to offend, it may b said that they lack the training in public morality which education on British lines might be expected to develop. By long tradition the Chinese have a devotion to education which amounts almost t veneration; but that they themselves recognise the defects of their system is shown by the efforts a reformation which they have made since 1911. Chinese education is now under the control of a Minister o Education, and with Peking as administrative centre there is a national system which includes primary and secondary schools, colleges and several universities. China thus possesses the skeleton of a system; but it must be confessed that it is nothing more than a skeleton, and perhaps, to continue the metaphor, not very successfully articulated. In addition, account must be taken of a number of educational institutions of all grades partly or wholly under foreign management, to a great extent the result of missionary enterprise.

The problem how best to utilise the resources which would be made available by using the Boxer Indemnity is in reality twofold. Although it has been possible to touch upon conditions in China only in the most cursory manner, probably enough has been said to show that a prolonged training is necessary before the

country can take the place in the comity of nations to which its importance, particularly in commerce, and its ancient civilisation might lay claim. Nor has anything been said of the danger to the rest of the world which lurks in neglect of this aspect of the question. It follows, however, that on one hand means should be found to give every assistance to the efforts of the Chinese themselves to reform and regenerate their educational system: on the other, it is urgently necessary to secure that such efforts at reform should be inspired by ideals of public and international morality in consonance, but not necessarily identical, with those of Western nations—a not insoluble problem, as is shown by the example of Japan.

It is evident that two considerations must be kept to the fore. In the first place, the sum available is small in proportion to the needs of so vast and so thickly populated a country, and as the funds come to an end in twenty-three years, permanence in result can only be secured by the co-operation of the Chinese themselves. Secondly, however, much as it may be desired to inculcate the spirit of a Western ideal, the education should be thoroughly national in character. The denationalised Chinese student is providing an element of danger in the present political situation which, with extended facilities for education on the lines of which he is the product, might become exceedingly grave. It is therefore necessary that most careful consideration should be given to any scheme which invites or requires Chinese co-operation such as was suggested by the representatives of the British Chambers of Commerce in conference at Shanghai in February 1923, who while urging emphatically that the funds from the Boxer Indemnity should be applied in the direction of education on British lines, regarded it as essential that in distribution there should be "adequate representation of China's opinion," or such a scheme as that outlined recently in these columns (August 30, p. 301), and also by Dr. R. P. Scott in the November issue of the *Empire Review* (see NATURE, November 15, p. 726). These schemes take into account the broad issues we have stated, namely, that, so far as possible, China as a whole should benefit in the exercise of British goodwill, that the fundamental considerations for success are real co-operation and sound finance; also, that higher education is the only field on which effective co-operation is feasible.

In conclusion, there are two points to which it is hoped attention would be given in working out details. One is that, in addition to scholarships for Chinese students tenable in Europe or America, there should be an exchange of lecturers for periods of at least a year; and secondly, that ample provision should be made for research in the geography, social history, and economics of China.

The Glands that regulate Sex.

The Internal Secretions of the Sex Glands: the Problem of the "Puberty Gland." By Prof. Alexander Lipschütz. With a preface by F. H. A. Marshall. Pp. xviii + 513. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd.; Baltimore, Md.: Williams and Wilkins Co., 1924.) 21*s.* net.

THE field of sexual physiology has been so active since "Die Pubertätsdrüse und ihre Wirkungen" was published in 1917, that it has been found necessary to rewrite the book and to give it a new title. Comparison of old and new provides a clear indication of the advances that have been made and of the modifications in opinion—including the author's own—that they have caused. The book is well planned and well written (in English): the illustrations are bountiful and excellent. There are a few of the inevitable typographical errors, and occasionally the author might perhaps have been happier in the choice of his word. But these are merely finicky fault-findings. This book can be strongly recommended to all those for whom the sections in Marshall's "Physiology of Reproduction" dealing with this subject are not sufficiently complete or recent, for in his treatment of the problems of sexual differentiation the author writes as a master.

The general theme of the book is that "in the ontogenetic development of the soma there is in the beginning an asexual stage, the subsequent differentiation of which is caused by the formative action of the sexual glands" (Steinach 1912, Lipschütz 1917). It is submitted that the soma is indifferent in the sense that either male or female sex-characters can develop, according to the kind of the sex-hormone, male or female, produced by the gonads. It can be said that the author has no difficulty in showing that in the mammal the sex-glands elaborate hormones which are able to modify the organism in a sex-specific way.

The book is of particular interest for the reason that it demonstrates in the clearest possible way the interrelationship of genetics and physiology. The problems of sex-determination have been appropriated by the geneticist, those of sex-differentiation by the physiologist, and as yet there is no link between the two. The author falters when brought face to face with the sex-chromosome sex-determining mechanism and finds it difficult to reconcile his theory of sexual differentiation with the established facts of sex-determination. The point of view of the physiologist is expressed in the statement (p. 104) that "*ceteris paribus*, femaleness depends on the ovary, maleness upon the testicle." The geneticist agrees that in the mammal, if an individual is to assume the sexual characterisation appropriate to the male, there must

be present in its body a functioning testicle, that *phenotypic* maleness (*i.e.* maleness as expressed in characterisation) depends on the testis, phenotypic femaleness on the ovary; but from the point of view of the geneticist, an individual develops a testis because it is a *genotypic* male, an ovary because it is a genotypic female.

Maleness and femaleness are characters in the Mendelian sense and are based upon hereditary sex-determining factors brought into the zygote by the conjugating gametes. In the genotype (the factorial constitution) of each zygote there are male-determining and female-determining factors, and these, it must be assumed, elaborate specific sex-differentiating substances. In the genetically determined male it is the rule for the balance between male- and female-determining factors to be such that the male-differentiating substances are efficiently in excess at that time during the development of the individual when the differentiation of the gonads occurs, and under these conditions the gonads become testes. In the determined female, on the other hand, the female-differentiating reactions are in excess at that time, and so the gonads become ovaries.

In order to bring the geneticist and the physiologist into agreement it is only necessary to extend the conception of asexuality, so ably developed in this book, so as to include the gonads. In the development of the gonads there is in the beginning an asexual (indifferent) stage, the subsequent differentiation of which is caused by the formative action of the sex-differentiating substances elaborated by the sex-determining factors. The embryonic gonad, according to the kind of internal environment (established by the sex-determining mechanism) in which it finds itself, can develop into either ovarian or testicular tissue.

The case of the free-martin (p. 389) has not been completely explained by the physiologist. The free-martin is a genotypic female whose sex-differentiation has been directed by the sex-hormone of its male co-twin, and whose sexual organisation is consequently abnormal. Difficulty is made of the fact that whereas the tissues of the genotypic male respond completely to the stimulus of the internal secretion of the testes, those of the genotypic female fail to do so. It is known that genotypic male and female tissues are to be distinguished by differences in their chromosome content and therefore, it may be assumed, in their physiological constitution, and it is reasonable to expect that, though both kinds may be capable of responding to one and the same stimulus, they will respond differentially. In the case of the free-martin, the male co-twin develops testes because he is a genotypic male and the testes elaborate the male sex-hormone. This, passing into the body of the genotypic female before her gonads have differentiated into ovaries, swings her sexual differentiation in the male direction. The swing is not complete becau the sex-hormone of the testis is not equivalent physi logically to the sex-differentiating substances elaborat by the male sex-determining factors and because t tissues of the genotypic female are constitutionall different from those of the genotypic male.

In dealing with the question of the physiologic action of the gonad in the fowl, the author, naturall enough, draws largely upon the work of Pézard and h collaborators, and with their opinions the geneticis frequently finds himself in disagreement. On p. 46 for example, the fact that Brown Leghorn cock an Silver Dorking hen threw daughters with the plumag characters of the Brown Leghorn, whereas Dorkin cock and Leghorn hen gave daughters with the plumag characters of the Dorking, is interpreted as a case of sex *limited* inheritance and the different plumage characte of the two kinds of daughters as an indication o a racial specificity in sex-hormone activity on th part of two different kinds of ovarian tissue. Pro Lipschütz suggests that, if this theory is correct, ovario tomy of the two kinds of daughters should give th same result, namely, a plumage presenting a mixture o characters of Leghorn and Dorking, whereas, if such castration experiment were to result in the plumage o a Leghorn poularde in one case and of a Dorkin poularde in the other, it would be necessary t reject the theory. We assure him, however, that thi very experiment has been undertaken, with the resul that Leghorn and Dorking characterisations wer obtained. There is not the slightest reason to cal upon any product of the ovary in order to interpre these straightforward results of a mating involvin sex-*linked* inheritance. It is enough to postulate tha gold and silver are allelomorphic characters, that thei factors are resident in the X-chromosomes, and that the female is the heterogametic sex.

Minoura's work on the artificial free-martin in the chick, to which reference is made (p. 311), demands critical repetition before it can be accepted as evidence of sex-hormone action. Any one who is well acquainted with the marked variability in the differentiation of the gonads and associated ducts in the chick must consider that Minoura's results were possibly due to simple interference with the normal process of sexual differentiation leading to irregularity and retardation, being in no way indicative of a specific action on the part of the implanted ovarian and testicular tissues.

In breaking a lance with his authorities, we do not criticise the author of this book; we merely take advantage of the appearance of so good a book to record our regret that it is not always possible for the physiologist to be well versed in genetics, the geneticist in sexual physiology. F. A. E. CREW.

Collective and Individual Effort in Colloid Chemistry.

(1) *The Theory and Application of Colloidal Behavior: Contributed by the foremost Authorities in each division of the Subject.* Edited by Dr. Robert Herman Bogue. (International Chemical Series.) Vol. 1: *The Theory of Colloidal Behavior.* Pp. xi+444+xx. Vol. 2: *The Application of Colloidal Behavior.* Pp. vii+445-829+xx. (New York and London: McGraw-Hill Book Co., Inc., 1924.) 2 vols., 40*s.* net.

(2) *Kolloidchemie und Biologie. Zugleich dritte Auflage von Kapillarchemie und Physiologie.* Von Prof. Dr. Herbert Freundlich. Pp. 47. (Dresden und Leipzig: Theodor Steinkopff, 1924.) 0.50 dollar.

THE editor of a collective work has, no doubt, a difficult and delicate task, and one would scarcely desire him to simplify it by adopting for his own and his collaborators' guidance the cynical maxim: "It does not matter what we say, as long as we all say the same thing." At the same time, while the sentiment expressed in the sentence is reprehensible, the commendation of unanimity or consistency contained in the clause deserves serious consideration.

(1) Such unanimity on fundamentals is quite conspicuously lacking in "Colloidal Behavior," more especially in the first volume, which deals with theory. In the preface, the editor dates the rise of a rational colloid chemistry from the application, by the late Dr. J. Loeb, of physico-chemical principles, *i.e.* Donnan's membrane equilibrium, to the colloidal behaviour of proteins, and confidently suggests that an extension of this method will explain the behaviour of all types of colloids. In the first chapter, Mr. J. A. Wilson attempts to give support to this view, and to apply the theory of heterogeneous equilibria to gold sols, by treating them as systems of three phases: "The solid surface, the film of solution wetting the surface, and the great bulk of solution." Whether it is in accord with classical physical chemistry to treat two regions of a continuous mass of liquid as distinct phases may seem doubtful.

In spite of the fundamental importance thus claimed for Loeb's theories (which, by the way, have not been unreservedly accepted by any one entitled to speak with authority in Europe), the authors of the remaining chapters appear to have little use for them. Prof. E. F. Burton refers to them (adversely) in one sentence in "The Kinetics of Disperse Systems," while Prof. McBain, in the brief but convincing chapter on "The Study of Soap Solutions," succeeds in explaining the behaviour of these typical colloidal electrolytes without ever mentioning membrane equilibria.

Again, in Chap. iii., Dr. J. H. Northrop professes "little doubt" that Perrin's logarithmic formula accurately expresses the vertical distribution of colloid particles. In Chap. v., Prof. Burton suggests that it holds over a range of about 0·1 mm. only, and quotes Porter and Hedges, who gave the complete law in 1922. These are all disagreements on fundamentals—those on minor points are numerous but need not be quoted. The experienced reader who knows the difficulty of keeping abreast of the widely scattered literature, who is aware that even sound theories become periodically unfashionable while unsound ones may stimulate research, will take such discrepancies lightly, but their effect on the student must be unfortunate.

While making every allowance for the difficulties of an editor who can scarcely exercise a censorship of all contributions (some of which, unless American authors differ radically from European, probably arrive in time to be sent to the printers by special messenger), one can reasonably expect him to do two things, if he makes such claims as Dr. Bogue does in his preface. The first is that the contributions should cover the whole subject, and the second that they should be arranged on some definite principle. The work fails in both respects; indeed, the omissions are remarkable. This is the first text-book on colloid chemistry which has no chapters on the ultra-microscope and its use, on the optical properties of sols (not even the Tyndall phenomenon is mentioned), or on viscosity. Nor does the work give any information on experimental methods such as dialysis (apart from a special apparatus briefly described by Prof. Freundlich), ultra-filtration or cataphoresis, though the reader is certainly entitled to look for it in a book claiming to be an advanced work of reference.

As regards arrangement, it is difficult to understand how chapters on the colloidal behaviour of the body fluids, on catalysis and enzymes, have come to be included in the theory of colloidal behaviour. The study of simple protein sols has no doubt helped to elucidate the properties of the highly complex mixtures which occur in organisms, but surely the reverse cannot be postulated. In the same way, while catalytic activity may be a very important property of a few disperse systems, it is not characteristic of the majority, and the study of catalysis can bear but indirectly on the theory of colloidal behaviour. The place for these chapters is obviously the second volume.

Incomplete and unco-ordinated as the material is, the first of the two volumes still contains a great deal that will be of interest to readers sufficiently grounded in the subject to exercise discrimination. The chapter on "Surface Energy" is welcome as a summary of the modern views on this fundamental subject by one of their distinguished originators, Prof. Harkins. Prof. Michaelis's article on "Adsorption" not only shows

how these views may be applied, but also incidentally brings out the highly specific character of adsorption by charcoal, the material used most widely in theoretical investigations. Prof. H. B. Weiser's contribution on "Jellies and Gelatinous Precipitates," and Prof. McBain's on "The Study of Soap Solutions," are valuable summaries, while Prof. E. C. Bingham in "Viscous and Plastic Flow" finds a subject which has not yet received due attention in Great Britain.

The second volume, which deals with the applications of colloidal behaviour to mineral, vegetable, and animal products, contains a vast amount of material impossible to summarise. It has often struck the reviewer as curious that colloid chemists should be so anxious to justify their existence or, perhaps, to magnify their office, by insisting on the applications of the discipline; writers on, say, physical chemistry, do not find it necessary to devote an exact half of their space to "applications." One of the reasons for this attitude may possibly be that the rapid development of colloid chemistry has fallen into a period during which science and an obscure activity called "research" have received much patronising commendation, not as objects in themselves but as possible agencies in the production of wealth. It would be unfair to suggest that the applications described in the work under review, or indeed in others, are all technical and quoted for their material results; in many instances the only claim made is that colloid chemistry has provided a new method of attacking problems of a purely scientific character. But the wish to make such claims has rendered the term "application" very elastic; it may connote a mere restatement in colloidal terminology, or an actual imitation or model of natural processes carried out in colloid material such as used by Nature. Every variety between these extremes is represented in the second volume.

(2) Prof. Freundlich's brief "Kolloidchemie und Biologie," the reprint of an address, also treats of one application of colloid chemistry. That it should here be placed beside the first collective work on the subject is (so far as the reviewer is concerned) an accident which has its piquant side, as the name Freundlich immediately calls up recollections of the greatest individual achievement in the literature of colloids, his "Kapillarchemie." Dr. Bogue must have overlooked it when he wrote in his preface, ". . . no attempt has heretofore been made to gather together material for an advanced text or reference work. . . ."

In the pamphlet under review, the author begins by reminding the reader that all organisms are built up from colloidal material, and then proceeds to show how the increasing knowledge of the colloidal state may be utilised by the biologist and physiologist. The parts played in living tissues by adsorption, electric charges at boundaries, swelling of elastic gels, are not only discussed in general, but each is also illustrated by concrete examples. Many of these are of great interest: thus the elucidation of hydrocyanic acid poisoning by a model in which the active factor—structural elements containing iron—is the same as in tissue. The striking fact that organic structures may, in the course of life, be completely transformed chemically while the appearance revealed by the ultra-microscope or even by X-ray analysis remains unaltered is shown to have its inorganic parallel in bodies capable of reacting rapidly throughout their mass, like the natural and artificial zeoliths, etc.

The brief but highly stimulating survey will be read with profit both by biologists and colloid chemists. It may perhaps induce a few adventurous spirits among the latter to forsake the well-trodden path, to abandon gold sols for a season, and to try their hands at what is surely the most important and most fascinating "application" of colloid chemistry—the elucidation and imitation of the phenomena of life. E. HATSCHEK.

Eddington's Relativity.

The Mathematical Theory of Relativity. By Prof. A. S. Eddington. Second edition. Pp. ix+270. (Cambridge: At the University Press, 1924.) 20*s*. net.

THE second edition of Prof. Eddington's book is a reprint of the first edition with the addition of a number of supplementary notes and one or two corrections. Some of the notes are designed to remove misunderstandings such as are constantly met with in debates on the relativity theory. Others give alternative mathematical treatments of various points, as, for example, the establishment of the four mathematical identities which correspond to the condition of conservation or permanence of the material world.

The main new matter contained in the notes falls under two heads—gravitational waves and affine geometry. Note 7 gives a summary of new results in the study of gravitational waves, and shows that the absolute disturbance is propagated with the velocity of light. At first sight there are other waves of a semi- or completely longitudinal type which may travel with a different velocity, but, in the picturesque language which Prof. Eddington still maintains, "these are merely sinuosities of our co-ordinate system. They exist, not in the world, but in our mental attitude, and the only speed relevant to their propagation is the speed of thought." Note 8 is a very interesting discussion of the gravitation of waves set up by a spinning-rod. This had been previously discussed by Einstein. The author gives a new discussion which confirms

Einstein's calculation save for a factor 2. The effect of the waves is to produce a loss of energy at the rate $32k\mathrm{I}^2\omega^6/5$ where $k = 2{\cdot}7 \times 10^{-60}$ in C.G.S. units, I being the moment of inertia, and ω the angular velocity. This is an effect of the third order as compared with that expected by Laplace if gravitation travelled with the velocity of light.

Notes 13 and 14 refer to the recent developments of "affine" geometry, as distinct from metric geometry, and the consequent generalisations of the relativity theory. In the latter note an account is given of Einstein's recent work in this region (Berlin *Sitzungsberichte*, 1923). Einstein supposes that there exists an action which has a stationary value for all variations of the threefold set of coefficients which define the affine connexion, and shows how this may lead by a special choice of the action function to the same results as those obtained by Weyl and set out in § 90 of the text.

There is to be noticed a slight movement in the attitude of Prof. Eddington to the universe as a whole. In the concluding page of the first edition it is remarked that "it is perhaps likely that, after the relativity theory has cleared away to the utmost the superadded laws which arise solely in our mode of apprehension of the world about us, there will be left an external world developing under specialised laws of behaviour." In the concluding note in the present edition, physics is definitely divided into two parts, one of which we are competent to deal with by our methods of continuous analysis, and the other we are not competent to deal with. "We do not pretend to predict *a priori* how nature will behave, but it is not impossible to set limits to the behaviour of that part of nature with which we are competent to deal, if we know the limits of that competence." This careful and conservative statement will remove misunderstandings that hasty readers have formed from passages that might be quoted from the earlier text.

The bibliography has not been revised, but the most important papers that have appeared since the first publication are referred to in the notes. E. C.

British Desmidiaceæ.

A Monograph of the British Desmidiaceæ. By the late W. West and the late Prof. G. S. West. Vol. 5, by Dr. Nellie Carter. Pp. xxi + 300 + 39 plates. (London: Printed for the Ray Society, 1923.) 37*s.* 6*d.*

PROGRESS in the study of a difficult group such as the Desmidiaceæ depends to a very large extent on the publication from time to time of treatises giving an adequate representation of the momentary state of our knowledge. In the past, we have been indebted to de Brébisson, Lundell, Ralfs, and others for works that gave a great impetus to the study of this group. During the latter half of the nineteenth century, Ralf's "British Desmids" indeed formed the standard work of reference, but as the years advanced it became more and more out-of-date, and a new monograph was long overdue when the publication of Messrs. West's "British Desmidiaceæ" commenced in 1904. There can be no doubt that this work, which in thoroughness and general excellence far exceeded anything hitherto produced in this direction, marked a great step forward, epitomising as it did the extensive researches that had been carried out in the last quarter of the last century, and placing at the disposal of the scientific world the prolonged and unrivalled experience of two of the foremost algologists of the time. Its influence was almost immediately manifest and has become increasingly so with the publication of successive volumes.

That neither father nor son should have lived to see the completion of their great work is to be deplored from every point of view, but in the absence of their lifelong experience, the choice of Dr. N. Carter to undertake the compilation of the fifth and last volume was a particularly fortunate one. Trained by the younger West, and having worked on Desmids for several years in his laboratory, probably no better person could have been found. Her task was not an easy one, as, apart from numerous drawings, Prof. West left but very few notes on which the subject matter of the fifth volume could be based. The text is thus entirely Dr. Carter's own work, and she may be congratulated on having produced a volume that in no respect shows any falling off as compared with the earlier ones. In particular, the critical remarks that are appended to the descriptions of many of the species, are often very much to the point. A large number of the figures are reproductions of Prof. G. S. West's own drawings, but Dr. Carter has had to supplement these to a considerable extent. Her own excellent drawings in the majority of cases have been made from material identified by Prof. West, so that, so far as the figures on the plates are concerned, they practically represent the latter's opinion of the characters of the different species and varieties.

The greater part of the volume is taken up with the completion of the genus Staurastrum, the treatment of which was commenced in the fourth volume published eleven years ago. So much confusion reigns with reference to certain species of this genus (*e.g. S. paradoxum, S. gracile, S. simonyi*) that an authoritative account of some of them is particularly valuable. The last sixty pages are devoted to the colonial Desmids, which, in correspondence with the plan adopted in the first volume of the monograph, are treated together,

though probably more closely allied to certain of the non-colonial genera than to one another. The addenda include an amended diagnosis of the genus Roya and a redistribution of some of the species of Penium considered in Vol. 1, necessitated by Lütkemüller's work on the structure of the Desmid-membrane.

Those interested in the study of Desmids will particularly welcome the excellent index to the five volumes with which the present volume concludes, and which, in view of the involved synonymy, will greatly enhance the usefulness of the whole work.

F. E. FRITSCH.

Our Bookshelf.

Die natürlichen Pflanzenfamilien : nebst ihren Gattungen und wichtigeren Arten insbesondere den Nutzpflanzen. Begründet von A. Engler und K. Prantl. Zweite stark vermehrte und verbesserte Auflage herausgegeben von A. Engler. Band 10 : Musci (Laubmoose). Hälfte 1. Pp. iv+478. (Leipzig : Wilhelm Engelmann, 1924.) 30 gold marks.

ONLY those bryologists who worked in the 'seventies and 'eighties of the last century can realise the great difficulties which then existed in determining mosses which came from outside Europe. Karl Mueller's "Synopsis Muscorum Frondosorum," published in 1849, had become obsolete so far as its classification was concerned, and Jaeger's "Adumbratio," although putting forward a more natural classification, was entirely destitute of descriptions, which the student had to search for in a widely scattered literature. In 1898 this state of affairs was altered when the Musci were reached in Engler and Prantl's "Die natürlichen Pflanzenfamilien," the bulk of which, after special sections by K. Mueller, W. Ruhland, and C. Warnstorf, was from the pen of Dr. V. F. Brotherus, the publication of whose task was completed in 1909. The appearance of this last-named work rendered the task of bryologists easier, and caused such an accession to their ranks as to necessitate the production of a second edition, the first part of which has just been issued. It consists of a compact volume, which, like its predecessor, is copiously illustrated. A general account of the mosses (including Sphagnales and Andreæales) is given by W. Ruhland, and a special account of the Sphagnales by H. Paul. These occupy 142 pages. The remainder of the groups from Fissidentaceæ to Timmiaceæ has been worked out by the veteran Dr. V. F. Brotherus, who has the opportunity of examining types additional to those used in the preparation of the first edition.

The general plan of the work follows that of the earlier edition, and so renders its use easy to those already accustomed to this plan. Each group contains a key to the genera, and also in very many cases short diagnostic characters of the species, which greatly facilitate the identification of specimens. This is especially noteworthy in the case of the genus Bryum, which occupies 38 pages and contains a large proportion of the 800 species which are widely scattered over the earth and the determination of which has hitherto been a matter of great difficulty. References are made to publications up to 1922 in which new genera have be described. The book should prove a great stimulus the study of bryology, and we trust that ere long I Brotherus may be able to issue another instalment this work, which his long experience renders him competent to perform.

Permeability. By Prof. Walter Stiles. (*New Phy logist* Reprint, No. 13.) Pp. v+296. (Londo Wheldon and Wesley, Ltd., 1924.) 12*s.* 6*d.* net.

THERE is no doubt that Prof. Stiles has rendered a ve considerable service to physiologists by collecting ar arranging the large amount of material dealing wi the plasma membrane and permeability. As remarks, "Any one who takes the trouble to read t literature of the subject can scarcely fail to be impress by the isolation of thought of the majority of worke in this field." A monograph of this nature remov any excuse for such a state of affairs.

The work is of general interest to physiologist although it naturally refers chiefly to plant tissue The various chapters deal thoroughly with the exper mental evidence on which our knowledge of cell ar protoplasmic structure is based. The physical ar chemical behaviour of such systems is considered, ar finally the movement of water and other substanc into living plant cells. The last chapter is devoted the statement of the various theories of cell pe meability. A bald outline of these subjects cannot d justice to the thoroughness with which they are treate Two main features mark the treatment. The ant thesis between Haberlandt's view that "every prot plast is surrounded by a special dermal layer," an Fischer's statement, "There are no membranes abo cells," is considered in a critical presentation of th evidence on which these views must be based. Th second feature of Prof. Stiles's treatment may expressed in his own words, "While the propoundin of theories will continue to satisfy the minds of som yet it cannot be too strongly emphasised that what a wanted to lay the foundations of a proper understanc ing of the phenomena of permeability in plants a facts, and particularly quantitative data." This poin of view has been kept in mind throughout. The resul is a work of reference of great value, comprehensiv impartial, and, it may be added, non-committal. W may perhaps hope for a further contribution fro Prof. Stiles, in which he puts forward, however briefly his own views on these vital subjects.

The Leucocyte in Health and Disease : Being an Enquir into certain Phases of Leucocytic Activity. By C. J Bond. Pp. viii+84+24 plates. (London : H. K Lewis and Co., Ltd., 1924.) 12*s.* 6*d.* net.

THE sub-title of the volume under notice gives the mor accurate idea of its contents, for it deals almost entirel with the author's own researches during the last seve or eight years. Since Metchnikoff's views on phago cytosis aroused such wide interest, much study ha been devoted to the functions of the white bloo corpuscles and the part they play in resisting disease Most of such experiments are naturally done outsid the body, and it is difficult to know how far the observe facts are valid under more natural conditions.

The author is well aware of this difficulty and ha

made every effort to study the living cell under conditions as natural as possible. He describes certain appearances in the white cells during their activity and certain fine processes called dendrites, which function in much the same way as the blunter pseudopodia. These are illustrated by some excellent plates, but neither these nor his arguments convince one that the appearances are not artefacts, although his reasons are put forward very lucidly and temperately.

The most interesting and original part of the book is the attempt to probe into the chemical processes taking place in the leucocyte. Two substances are described. One of these occurs in the cell and stains readily with iodine, and may be of the nature of glycogen; the other readily diffuses from the cell and can be shown in the surrounding media, and it stains with benzidine and differently with iodine. It is not one of the ordinary oxidases and is probably aldehyde in nature. The author claims that if the leucocytes are incubated with glucose, more of the latter diffusible substance is produced in the presence of insulin.

The book cannot be recommended to the general reader, but will be of interest to the specialist. It seems to the reviewer that the experiments and the theoretical discussion would be better in the pages of a journal devoted to this subject than issued as a separate monograph.

Across the Great Craterland to the Congo: a Sequel to "The Wonderland of the Eastern Congo." Describing a Journey of Exploration and Research to the Land of the Giant Craters in Tanganyika Territory, and to the Forests, Lakes, and Volcanoes of the South-Eastern Congo; with some Account of the African Apes, and the Capture and Training of the African Elephant. By T. Alexander Barns. Pp. 276+64 plates+2 maps. (London: Ernest Benn, Ltd., 1923.) 25*s.* net.

CAPTAIN BARNS'S volume on his expedition in 1921–22 from Mombasa to the Congo at Stanleyville and thence to Capetown is a valuable contribution to the natural history of Central Africa. The author combines the qualities of a daring explorer and hunter, of a keen observer of man and Nature, and of a graphic and interesting narrator. The primary object of the expedition was the discovery of a large butterfly which has been seen on the Upper Congo, but has not yet been captured. On his way to the haunts of this elusive insect he explored a remarkable group of volcanic mountains and basins in northern Tanganyika Territory, and collected skins of some of the third species of gorilla, *G. berengei*, in the forests of Kivu. He also made a large collection of Lepidoptera, including many new and rare forms.

Capt. Barns has written an interesting account of the geography of the region north of Lake Tanganyika. The chapter on the gorillas contains valuable information as to their habits; another is devoted to the adventurous story of the domestication of the African elephant by the Belgians. The volume has an introduction by Prof. J. W. Gregory discussing the nature of the great volcanic basins explored by Capt. Barns. That of Ngorongoro is eleven miles in diameter. He concludes from the geological evidence available that they were not formed as craters, but as calderas or volcanic cauldrons. He defines the distinction between ordinary upbuilt craters, explosion craters and calderas or cauldrons, which have been formed by the collapse of the ground around a volcanic vent. The volume is illustrated by many beautiful photographs, especially of the scenery and big game.

An Introduction to Reflective Thinking. By Columbia Associates in Philosophy: Laurence Buermeyer, William Forbes Cooley, John J. Coss, Horace L. Friess, James Gutmann, Thomas Munro, Houston Peterson, John H. Randall, Jr., Herbert W. Schneider. Pp. vii+351. (London: Constable & Co., Ltd., n.d.) 10*s.* 6*d.* net.

THIS is one of those co-operative books which are becoming a feature of publishing enterprise. It has, however, some quite exceptional marks. The nine authors, members of the staff of the Department of Philosophy in Columbia University, are named on the title-page, but their individual contributions are not specified in the text. We are told in the preface that they sought advice and received aid from their colleagues in other departments. The book therefore has, and is intended to present to the student, a unity due to team work. It is offered as a first course in philosophy or as an introduction to science. Each chapter is divided into sections and followed by a list of questions and exercises and an extensive bibliography. The impression it leaves on us is that the interest of the matter is spoilt by the form, and the matter apart from the form is elementary to the point of insipidity.

Vibration in Engineering. By Julius Frith and Frederick Buckingham. (Reconstructive Technical Series.) Pp. xiv+123. (London: Macdonald and Evans, 1924.) 7*s.* 6*d.* net.

AN increasing degree of attention has been given recently in engineering colleges to the study of vibrations, and students will welcome the appearance of this volume in which has been collected a large amount of information hitherto scattered in various volumes dealing with physics and in technical journals. The matter is arranged in two parts, physical and mathematical, and vibrations commonly occurring in both mechanical and electrical engineering receive attention. For the most part the principles are stated clearly, but there are some loose statements which require amendment, *e.g.* on p. 11 we read, "The restoring force is now a turning moment, the force is measured in pounds weight as before, and its moment in feet."

Spinoza, Descartes and Maimonides. By Dr. Leon Roth. Pp. 148. (Oxford: At the Clarendon Press; London: Oxford University Press, 1924.) 7*s.* 6*d.* net.

DR. ROTH has produced a scholarly book. The author rejects the view that Spinoza is originally a follower of Descartes and that the purpose of his speculation is to develop the logical consistency of the Cartesian principles. He holds that he is mainly concerned to oppose and overthrow the theory of Descartes, and that he does so by recovering and reanimating the four-centuries-old doctrines of Maimonides in the "Guide to the Perplexed." The argument is not lightly to be set aside but it is scarcely likely to be convincing.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Rarity of the Inert Gases on the Earth.

IN NATURE of March 15 I published a diagram in which the abundance of the different species of atoms —up to mass number 79—was plotted on a log scale against their mass numbers. I have now extended this, with a small gap, up to mass number 142, and what was fairly obvious before has become, by the inclusion of the region containing xenon, a very striking feature. This is the abnormal scarcity of the inert gases.

I took for purposes of calculation an earth consisting of the atmosphere, the hydrosphere and a lithosphere of the average composition of the igneous rocks of mass equal to that of the whole globe. If we disregard the inert gases altogether, the points lie on at least the semblance of a curve. There are high peaks, O, Fe, Sr, Ba, abnormal depths, Sc, In, and a very marked depression in the region Ga, Ge, but nevertheless a curve is sufficiently well marked for any observer who had been given the mass numbers of the missing inert gases to allot them appropriate positions and so to calculate their most probable abundance. The point I wish to emphasise is that he would in every case state an abundance roughly 10^6 times greater than that obtained from actual atmospheric analysis.

This discrepancy will appear much the same if instead of mass number we plot by atomic number or by atomic weight, and it will not be affected seriously by supposing, as has been suggested, that the innermost quarter of the earth consists mainly of iron and nickel. It cannot very well be ignored, and three possible hypotheses suggest themselves, any or all of which might offer an explanation :—

(1) The fault lies in the method of calculating abundance; our sample is unfair, and if we could get a fair one, say from the interior of the earth, the discrepancy might vanish. This would require that the earth's atmosphere was entirely derived from a surface shell only a few metres thick—not a very hopeful view.

(2) The abnormal rarity of the inert gases is due to some nuclear property of instability held in common. We have good reason for supposing such a property common to the isotopes of a single element, but none whatever to ascribe it to a set of elements the mass numbers of which range from 4 to 136. It is true that these elements have a very definite property in common, chemical inertness, but this is, so far as we know, an extranuclear one. We are therefore driven to consider as more probable :—

(3) The earth has only one millionth part of its proper quota of inert gases. This very interesting conclusion is founded on very flimsy evidence, but it is not out of keeping with some such origin of the solar system as the planetesimal theory. In the hurly-burly of colliding bodies ranging in mass from atoms upwards, the atoms of the inert gases, unconstrained by irrevocable chemical combination and free to collide and rebound indefinitely, would inevitably gravitate towards the larger masses and forsake the less. On this view the earth's share of inert gases has been lost to the sun, though whether they still remain there unchanged is outside the question. Their abnormal rarity is at least a point of interest and invites comment from those interested in the evolution of our system and of the elements. F. W. ASTON.

Cavendish Laboratory,
Cambridge, November 19.

The Cause of Cyclones.

IN the winter of 1922–23 there appeared in NATU some correspondence on "The Cause of An cyclones," and on that occasion I put forward cert views as to the mechanism by which the more ra increases of barometric pressure are brought abo in temperate latitudes (NATURE of March 31, 192 pp. 429-430). The present communication may regarded as a sequel in that its object is to descri a mechanism by means of which the more ra reductions of pressure can conceivably be produc The idea arises naturally from consideration of series of papers by Helmholz appearing in t *Sitzungs-berichte* of the Royal Prussian Academy Sciences in 1888 and 1889, dealing with the equilibriu of rotating rings of air at different temperatur and with the theory of winds and waves whe strata of different density lie contiguous with o another.

The conditions for equilibrium in cases where surface of discontinuity (of temperature and win exists in the atmosphere have since that time be dealt with by V. Bjerknes and others in som what more general fashion and need not be set o here.

Designating the warmer (southerly) mass by (and the colder (northerly) by (2), Helmholz calculat in terms of their velocities, temperatures and t latitude, the theoretical slope of the bounding surfa for a state of stable equilibrium. But, as he poin out, first small waves and then mixing of the tv media must soon occur over this boundary; H therefore calculates the slope for stability of t bounding surface between mass (2) and the mixtu and between the mixture and mass (1). He sho that these slopes are respectively more acute a less acute (relatively to the horizon) than the origin slope between mass (2) and mass (1). Hence, H says, results the important consequence that (tending towards the new requirements for equilibriu "all newly formed mixtures of strata that *were* equilibrium with each other must rise upwar between the two layers originally present, a proce that of course goes on more energetically when pr cipitations are formed in the ascending masse While the mixed strata are ascending, those parts the strata on the north and south that have hithe to rested quietly approach each other until the even come in contact, by which motion the diffe ence of their velocities must necessarily increas since the strata lying on the equatorial sid acquire greater moment of rotation (about th earth's axis) with smaller radius, while those o the polar side acquire feebler rotation with a large radius."

Now the importance of this reasoning, applied i the light of modern meteorological knowledge, appea to me enormous. Putting aside for the moment a theories as to the *origin* of cyclones, it appears to b pretty well established by the facts of observatio that the normal *structure* of an active and recentl formed depression at least approximates to that de scribed by Bjerknes.

Further, observation tends to confirm (1) that th principal reduction of pressure and the principal are of rainfall lie at any moment within the "old" col air in front of the Bjerknes Steering Line, (2) tha where the warm air extends right down to the groun no appreciable pressure-change is taking place, unles quite close to the Steering Line, (3) that where th "new" cold air is undercutting the warm air ther is rapidly rising pressure.

I have shown elsewhere that the rise of pressur in the new cold air and the comparative constancy

of pressure in the warm air and also the temperatures of these masses are consistent (dynamically) with their (supposed) northerly and southerly origins and with the processes to which they have been subjected in arriving on the field of operations; and further that the changes in the energy (potential, kinetic and internal) of the "new" cold current are sufficient to account for the work that is being done by it in displacing the warm air and filling up the rear of the depression. But I have never previously been able to see why in front of the depression the warm air should mount upon the old cold air, or why, if it did so, a fall of pressure should at the same time occur in the region below; though I have indeed been able to find evidence that a selected mass within the warm air was continually approaching a selected mass within the old cold air. Now if the Helmholz reasoning is sound we can make an important step forward. The mysterious "eviction of air," as Sir Napier Shaw has called it, is accomplished by the continual procession of the products of mixing of the warm and cold up a kind of giant escalator—with a moving roof as well as steps—hitherto described usually as the Steering Surface; and the process would go on so long as any warm sector remained.

At the moment I can see no fact of observation that is inconsistent with such a theory, and it further appears to lead to feasible energy equations for the front half of a cyclone.

In the problem dealt with by Helmholz the "eviction" and the subsequent "dumping" of the air do not seriously enter, and beyond the remarks quoted above, he devotes no consideration to either. As to the latter, Steering Surfaces appear to extend up to the level of the highest clouds and even into the stratosphere, and their inclination to the horizon appears to be of the order of 1 : 100. Hence the dumping need not take place within 1000 kilometres of the Steering Line and may be spread over an enormous area beyond that. The tracks of the most frequent North Atlantic depressions lie roughly parallel to the line of the (eastern) American and Greenland coasts, and in a belt about 1000 to 2000 kilometres distant from these coasts. The tracks of the North Pacific depressions are somewhat similarly situated with regard to Siberia. Of all places in the Northern Hemisphere the North America-Greenland area and Siberia would most welcome the dumping of surplus air and most of all at those seasons when depressions are most active. For these areas must be receiving air—probably at a high level—to compensate for the constant vertical contraction of the film of atmosphere there by cooling and for the recurrent discharges of cold air into the rear of passing depressions. In this way depressions might perhaps be regarded as the heat-receiving ends of thermo-syphonic arrangements, the corresponding radiating ends being areas like North America, Greenland, Siberia, or the Antarctic continent; both ends being necessary for the maintenance of the circulations. A secondary depression and its "dying" parent would perhaps bear a similar relation one to another. In all cases the principal supply of heat would be borne from equatorial regions by warm currents of high water vapour content. Given sufficiently complete synoptic weather charts of the northern hemisphere, to test the above theory by a combination of the facts of observation, hydrodynamics and thermodynamics would not, I think, be impossible, though the task would be one of some magnitude.

A. H. R. GOLDIE.

Edinburgh,
November 7.

Organ-pipes of Unusual Shapes.

THROUGH the kindness of Prof. W. B. Morton I have been enabled to examine Robert Gerhardt's original inaugural-dissertation on the Rohrflöte, delivered at Halle in 1884. His equation for the case of a pipe with closed chimney is identical with that given by Principal Aldis (NATURE, Aug. 30) for the Bicylindron, and for the Rohrflöte proper with open chimney his equation is the same as mine. Gerhardt discovered a little of the history of this interesting pipe register. The Rohrflöte is apparently of considerable antiquity. Praetorius mentioned it in his "Syntagma Musicum" (1619), and the pipe was probably invented in the middle of the sixteenth century. Praetorius describes the position of the chimney as being wholly outside, half inside, or wholly inside, of which he recommends the last as offering the greatest protection to the chimney.

The theory of such a system was given by Bourget in 1873 in an explanation of the sound given when one cools a narrow glass tube, on one end of which a glass bulb has been blown. Without really extending the theory Gerhardt showed that by graphical means one can always calculate the possible frequencies of any such arrangement. He plots the curves:

$$y_1 = w \tan ml,$$
$$y_2 = -\tan mh$$

(using my nomenclature) and obtains the points of intersection:

$$ml = z\frac{\pi}{2} \pm \alpha,$$

where z is some whole number, α is found from the graphs and differs for every value of z, and the positive sign is taken for the Rohrflöte, the negative sign for the Bicylindron. Gerhardt therefore obtains for the fundamental frequency:

$$N = N_0\left(1 \pm \frac{2\alpha}{\pi}\right),$$

where N_0 is that of the pipe without a chimney when closed. In my previous letter (NATURE, Oct. 18) there is an error; $r/R = \tan \pi/n$ should read $\tan mh = \tan \pi/n$, where π/n is the least angle of which the tangent is $\tan mh$. Gerhardt's expression for the fundamental frequency gives the same values as mine although the form appears different. There is a mistake in my deduction of the overtones, and the given series is only true in some few particular cases. In general the interval between an overtone and its fundamental is $(zn+1)$, where z is an integer, but n is usually multivalued and the overtones quite inharmonic. It is obvious, however, that if the speaking length of the body is some simple multiple of that of the chimney, the points of intersection of the curves must repeat themselves after a definite interval, and hence in this case overtones occur which are simply related to one another. Gerhardt, however, considered the values of α in no way connected. His observations show excellent agreement with the values deduced from his graphs except when the ratio of the diameters approaches unity.

The whole subject of pipes possessing sudden changes of diameter has been attacked recently in a most comprehensive manner by P. Cermak of Giessen (*Ann. d. Phys.* 53, 1917). He first examined a closed pipe formed of two portions of equal lengths and of different diameters, and determined the change of pitch with change of the diameter ratio. The empirical law which satisfies these changes extremely well is

$$N = N_0(1 \pm \rho),$$

where N_0 is the fundamental frequency of a pipe of constant diameter and of the same total length, and

$$\rho = \left(1 - \frac{D_e}{D_w}\right)^{\frac{1}{4}},$$

where D_e and D_w are the diameters of the narrow and wide portions respectively. In the frequency formula the positive sign is taken if the narrow end is closed, the negative sign if one closes the wide end. The latter case is identical with that of the Bicylindron invented by Principal Aldis.

Cermak then proceeded to examine the change of pitch of pipes in which the two portions had a constant difference of diameter, when the junction was gradually moved from the narrow to the broad end, which was closed, and then for the opposite direction of movement with the narrow end closed, the total length being kept constant in both cases. He shows, as also did Principal Aldis, that the pitch in the first case falls to a minimum when the lengths of the two portions are equal, and then rises to its original value when the tube is once more uniform. Combining these results he obtains empirical formulæ giving the fundamental frequency of any closed pipe formed of any number of straight portions of any length and cross-section. His formulæ agree with his observations extremely well, but they are very complicated and most wearisome to handle.

Cermak obtains empirical formulæ for the case of the Rohrflöte, which also fit the results of experiment remarkably well, but he points out that Gerhardt's deductions differ from his observations most where his formulæ show best agreement, and vice versa.

From a brief examination of his curves, I should have expected that a formula built up from transcendental terms would be simpler, easier to handle, and give as good agreement, and, moreover, would give some insight into the physical meaning of the changes. Since Gerhardt's result admits only of graphical solution and conveys little sense of physical reality, one would welcome any equation, even though it were empirical, which might permit of the immediate solution of a problem, and if possible one which would admit of a simple physical interpretation. In the development of the compound resonator such formulæ would be invaluable.

Cermak's work is, moreover, extremely thorough. Of recent years many physicists have produced theories based on observations made with a single pipe, or at most three. Cermak used fifty-eight different pipes, and traced interesting analogies of the phenomena in the creation of longitudinal vibrations in rods of non-uniform section, in the transversal vibrations of strings having sudden changes of diameter, and in the resonance of electromagnetic oscillations in a parallel wire system in which the distance between the wires suddenly changes. To these I should like to add the effect of inserting a short length of wider tubing in a water pipe line in Constantinesco's wave-power transmission.

W. E. BENTON.

Department of Physics,
University of Birmingham,
November 5.

The Word "Scientist" or its Substitute.

THERE is a prejudice against this word. Some profess etymological scruples; they say it is an ugly hybrid with a Latin root and a Greek termination. But surely this is not a serious objection or the one which really prevents its use. For the accusation is not true. The termination *-ist* is French, not Greek; if "scientist" had come from the French it would have been as unexceptionable as "artist," which is an exact parallel; it did not come from French merely because French scientists, having appropriated *savant* (to which we have no close analogy), had no need of it. Even if the accusation were true, those who swallow "voltmeter" and "ionisation" would scarcely strain at such a very mild inelegance.

The real objection, I think, is different. "Scientist" was a doubtful neologism at a time when scientists were in trouble about their style. They were accused, with some truth, of being slovenly; and those who aimed at a higher standard were careful not to offer the slightest cause for offence. The word became a shibboleth. Matters have, however, now changed; we no longer need a shibboleth. Our sentences may not always be polished, but scientific journals contain no higher proportion of gross errors than the Proceedings of the Aristotelian Society or of the Classical Association. Moreover, the word has arrived; there is no chance of suppressing it entirely. Even if so far it were confined wholly to the illiterate—which it most certainly is not—we ought (as the authors of "The King's English" say) to "begin seriously to consider whether it has not been resisted as long as honour demands." Cumbrous circumlocutions, such as "man of science"—offensive to feminists and with an artificial air no artifice can conceal—are wretched substitutes. The idea is definite and important; the discovery that there is something common in the intellectual attitude of all the sciences and foreign to other branches of learning is one of the greatest advances made by the thought of the last century. For a new thing (to quote the same authors) we must have a new name.

Let me therefore plead with you, Sir, who have done so much to raise the standard of scientific literature, and with all others who have striven to show that scientific and linguistic precision are not incompatible, to give us a lead in this matter. If you will not have "scientist," at least provide us with some other single word. NORMAN R. CAMPBELL.

[Hitherto the word "scientist" has not been used in the columns of NATURE to designate a man of science or scientific worker, and Dr. Campbell now suggests that the time has come to reconsider the exclusion of the word. Our language has grown into what it is through process of change and development, and there is no permanent standard of purity for it; so that new words and phrases are continually being incorporated while others are becoming archaic. The only criterion as to what is permissible is that afforded by refined feeling or usage in the best literature of a particular epoch. We have, therefore, invited a number of authorities on good English, including distinguished men of science, to favour us with their opinions on the desirability, or otherwise, of adopting the word "scientist" to signify generically one who has at different periods been described as a natural philosopher, naturalist, or man of science, and we propose to publish any replies received of a critical or constructive kind. EDITOR, NATURE.]

Cell-wall Formation.

A CHARACTERISTIC difference between the processes of cell-wall formation in plants and animals has long been recognised. In the tissues of higher plants a new cell-wall is generally laid down on the nuclear spindle and then spreads peripherally until it cuts the cell into two. The cell-wall may thus be said to be endogenous in its origin. It is also generally believed that this plate on the spindle is first formed by the coalescence of a row of granules, afterwards

splitting into two layers which secrete the primary wall between them. In animal cells, on the other hand, the characteristic method of division is by constrictions or furrows beginning at the periphery and proceeding inwards. The same is true of many Thallophytes.

In recent years the observations of Farr on Nicotiana, Magnolia, Sisyrinchium and other forms, of Tahara on Chrysanthemum, and of the writer on Lactuca (Proc. Roy. Soc. B., vol. 91, p. 222, 1920), have shown that in pollen mother-cells, quadripartition usually occurs by furrowing. Recent critical observations of this process in the pollen mother-cells of Lathræa (in a paper now in the press in *La Cellule*) show that there are, however, essential differences between the process of furrowing as it occurs in pollen mother-cells and generally in Thallophytes, and the manner of furrowing in animal cells.

In Lathræa, a new wall is first formed inside the pollen mother-cell wall. At four equidistant points on this wall tetrahedral thickenings or deposits then appear, and from the apices of these thickenings four furrows grow in until they meet in the centre of the cell. But as the furrows advance, a delicate cell-wall, which is a continuation of the peripheral thickening and which has usually been missed, is deposited in each furrow.

In animal cells, Spek and others have shown that cleavage is accompanied by peripheral currents in the cytoplasm moving in the direction of the furrows. Early observations of J. Loeb and others, recently confirmed by Chambers (in "General Cytology," Ed. Cowdry, p. 296, 1924), show that in various animal eggs as the cleavage furrow is formed pigment granules accumulate in the wall. This process is to be contrasted with the secretion of a wall in the furrows of a dividing pollen mother-cell. Observations of Chambers on cleaving animal eggs also show that an appreciable time is necessary for the walls of the furrow to become non-coalescent when they come into contact. This hardening effect may perhaps be due to the accumulation of these granules in the walls.

It thus appears that there is an essential difference between the process of wall formation in pollen mother-cells and the cleavage of animal cells. In both cases a furrow is formed, but in the former a delicate cell-wall is secreted as the furrow advances, while in the latter there is no such secretion. We may thus say that quadripartition in pollen mother-cells combines the essential features of both methods of wall formation.

R. RUGGLES GATES.

King's College, London,
November 10.

Nitrogen and Uranium.

YEARS ago, before the discovery of terrestrial helium, W. F. Hillebrand isolated this gas with nitrogen, in his work on rock analyses. Because a large amount of nitrogen was obtained he attributed all of the gaseous constituent to this source. Some of his analyses are described in the *American Journal of Science*, vol. 140, pp. 384-94, 1890, under the title, "On the Occurrence of Nitrogen in Uraninite and on the Composition of Uraninite in General," and more fully in Bulletin U.S. Geological Survey, No. 78, pp. 43-79, 1890. He concluded that "nitrogen exists in uraninite in quantities up to over 2·5 per cent., and seems generally to bear a relation to the amount of UO_2 present. This is the first discovery of nitrogen in the primitive crust of the earth." "The nitrogen is liberated from the mineral as nitrogen gas by the action of a non-oxidising inorganic acid and by fusion with an alkaline carbonate and probably also caustic alkalies in a current of CO_2." "In a Geissler tube under a pressure of 10 mm. and less, the gas afforded the fluted spectrum of nitrogen with great brilliancy." That uraninite is actually the source of the nitrogen is not open to doubt. Ramsay later confirmed Hillebrand's discovery. The chemical evidence suggests that the nitrogen was present in the mineral in the free state, as occluded gas. The question therefore arises as to how such a quantity of gas could accumulate. The unknown nature of its origin has been frequently mentioned by Dr. Hillebrand during the past thirty years.

Very likely the nitrogen is merely occluded in the uraninite in a manner similar to the occlusion of gases in charcoal. If so, this fact may prove important in problems of laboratory technique. From a more speculative point of view, however, in view of the fact that the atomic weight of uranium is almost exactly an integral multiple (17) of nitrogen, one is attracted to the possibility that the uranium nucleus may contain nitrogen nuclei. Further, the ejection of nitrogen of atomic number 7 from uranium should give the missing, and possibly unstable, element 85, with an atomic weight somewhat higher, to be sure, than should be expected. These latter questionable suggestions, wholly unsubstantiated by radioactive evidence, are offered merely to direct attention to the fact that the presence of nitrogen in uraninite is a problem of interest and importance.

PAUL D. FOOTE.

Bureau of Standards, Washington, D.C.

Edible Earth from Travancore.

IN the Travancore Court of the British Empire Exhibition at Wembley several interesting products of this enterprising State were displayed. Among the medicinal products there were two substances named "Kalpal" and "Kalmadom." From a description drawn up by Dr. Kunjan Pillai, these are said to be deposits found in the clefts and hollows of high rocks "in the form of a brownish-white foam which on exposure becomes harder with time and has the consistence of lime-plaster." The decomposed rock is washed with water to remove foreign matter, as lichens, leaves, etc., and the sediment is made up into balls and dried in the sun. The lumps reduced to powder are said to be a valuable medicine for kidney complaints.

Dr. Pillai has kindly supplied me with samples of these materials, and they were at once recognised as forms of prepared edible earth used throughout India —"Kalpal" was in the form of white balls consisting of sand and clay, while "Kalmadom" was in rounded lumps with the colour and appearance of ochre. In a paper on "Earth-eating and the Earth-eating Habit in India," published in the Memoirs of the Asiatic Society of Bengal, vol. 1, No. 12, 1906, and noticed in NATURE of September 27, 1906, Dr. Mann and I have described about forty different kinds of edible earths, with the results of their chemical analyses, and a history of the habit. They were all siliceous earths, containing in a few cases a fair quantity of iron or lime. In tea estates the coolie women use the unctuous clay taken fresh from exposed deposits, but in the cities the clay is baked and sold in thin plates of various sizes. The earths we examined in connexion with this remarkable habit included the following varieties: Hydrated silica, cream-coloured clay, finely divided felspar, marl, yellow clay, brown clay, greyish calcareous clay, reddish micaceous loam, talc-schist, laterite, halloysite, blackish grey clay, brown earth from ant-hills, and infusorial earth.

DAVID HOOPER.

The University, Bristol,
October 31.

Colour Nomenclature.

By Dr. L. C. MARTIN.

THE content and meaning associated with any word is always liable to vary with the mental outlook of an individual. Thus the word "distance" may convey to a psychologist the idea of a psychological experience developed by various means through the senses; to a physicist the same term conveys the idea of a magnitude to be expressed in centimetres or other arbitrary units. In practice, however, this causes very little inconvenience. The fundamental concepts are identical; it is the principle of measurement which varies.

Up to comparatively recent times the discussion of colour had connexion almost exclusively with the use of pigments, precious stones, and the like, in the decorative arts. Individual pigment names were satisfactory and not too numerous to remember, while the vast range of aniline dyes was unknown, but at the present time the use of colour names is in confusion. We recall the words of Locke: "Men take the words they find in use amongst their neighbours, and that they may not seem ignorant what they stand for, use them confidently without troubling their heads about a certain fixed meaning." We all suffer to some extent from this over-confidence. There is now a great need for some manner of measuring and specifying colour, which avoids the employment of these individual names.

The early work of thinkers and experimenters such as Newton, Young, Tobias Mayer, Johann Lambert, Runge, Grassman and Goethe cannot be reviewed here. We must begin with Helmholtz, who, inheriting the result of their labours, started with the basic idea of a three-dimensional continuum of colour sensations, the sensation being clearly differentiated from the stimulus. He was solely concerned with sensations when he described them ("Physiological Optics," 1856–66) as variable in terms of hue (Farbenton), saturation (Farben Sättigung), and brightness (Helligkeit). The subject of colour vision attracted great attention about this time, the work of Chevreul being translated (1854) into English by Charles Martel, who made in the introduction a plea for the more accurate standardisation of colour names by reference to the spectrum. Chevreul did not, however, trouble to distinguish between the sensation and the object seen; he describes colour variations by reference to the effects obtained by mixing white and black with various colours, but he uses the terms "tint" and "tone," which have not found acceptance for scientific work. Helmholtz had this in common in Chevreul, that he carefully described the physical conditions which would cause illustrative variations in the three sensation variables mentioned above.

Several other books, dealing with the subject mainly from the physical point of view, followed in the latter half of the nineteenth century. Benson (1871), having the benefit of Helmholtz's work, starts his account with the three fundamental sensations of the Young-Helmholtz theory of colour vision; this affords a radically different machinery with which to discuss colour sensation phenomena. It is still three-dimensional, but not so directly related to ordinary experience as the hue, saturation, and brightness. Rood ("Modern Chromatics" 1883) discusses "hue, luminosity, and purity," and describes experimental means of varying them in physical stimuli. His "luminosity" corresponds to the "Helligkeit" of Helmholtz, and his "purity" to "Sättigung." He takes even less care than other authors to distinguish between sensation and the stimulus, as the following quotation shows: "the hue of the colour or, as the physicist would say . . . the wave length." Abney ("Colour Measurement and Mixture," 1891) speaks of the "luminosity" of a coloured object, and the "purity" of coloured light, but when giving the results of some of the first actual colour measurements in such units he is sufficiently cautious to give: "Wave length of dominant ray," "percentage of white light," and "percentage of luminosity as compared with white." While he was very sparing in the use of terms which might have a psychological meaning, such as "purity" and the like, he thought it quite legitimate to connect sensation and stimulation in quite an arbitrary way, as Helmholtz did, by the postulate that equal stimulation of all three primary sensations of the trichromatic theory shall produce white. Moreover, the white was perfectly arbitrary; in Abney's case it was the white sensation evoked by the light from the crater of his carbon arc.

In passing, the distinction between various meanings of "white" may be made clear. A surface which reflects diffusively and non-selectively, and has a high albedo or reflection coefficient, is usually described colloquially as white. To the psychologist, however, white is sometimes a hueless sensation of light which happens to be brighter than any other sensation present in consciousness. Frequently, the distinction is not pointed out, and misunderstanding results. To the present writer the simplest conception to appeal to a physicist seemed to be that of the "whiteness" of sunlight (probably a psychologist would prefer to speak of "greyness"), which we learn to recognise in the whiteness of clouds and mist, and in the appearance of all diffusely reflecting and non-selective surfaces. The sensation due to the *light* is the first thing to grasp.

The importance of the "hue, saturation, and brightness" classification of colour is revealed in the colour charts which have been prepared on this basis, and the corresponding commercial colour notations. One of the most notable is that of Munsell, who employs the terms "hue," "chroma," and "value," where the latter two terms correspond to our previously used "saturation" and "brightness." This colour chart, which I have described elsewhere,[1] is in use for commercial purposes. Others on similar lines are also extant.

It will be realised from the foregoing notes that some co-ordination in the use of terms is extremely desirable, and to this end a committee of the Optical Society of America, under the chairmanship of Prof. L. T. Troland, published a report[2] in August 1922 which suggests

[1] "Colour and Methods of Colour Reproduction." Blackie, 1923.
[2] Journal Opt. Soc. Amer., Vol. 6, No. 6, 1922.

definitions for the three variables of colour *sensation*. They are as follows :

1. Brilliance is that attribute of any colour in respect of which it may be classed as equivalent to some member of a series of greys ranging between black and white.

2. Hue is that attribute of certain colours in respect of which they differ characteristically from the grey of the same brilliance and which permits them to be classed as reddish, yellowish, greenish, or bluish.

3. Saturation is that attribute of all colours possessing a hue, which determines their degree of difference from a grey of the same brilliance.

The reason for discarding the terms brightness and luminosity is that both these terms have received technical definitions [3] in connexion with photometric measurements. The Committee would retain the term saturation for the subjective attribute of colour sensation, while allocating the word purity to the "ratio of homogeneous to total radiation in the stimulus." According to the report, any definite physical application of these terms (brilliance, etc.) will "corrupt" them. Many other colorimetric matters and experimental methods are also dealt with in the report.

For practical colour measurement it is necessary to distinguish between the measurement of a colour stimulus such as obtained from the field in a spectroscope, and the measurement of reflected body colour. For the latter case the report describes the specification of colour in terms of (1) luminosity, (2) dominant wave length, (3) per cent. hue. Presumably the former case would best be met by using the term "brightness," but the use of the physical terms is still very variable. The colloquial use of the word "luminosity" is a little against its use as a contraction for "relative luminosity as compared with white."

We have not up to this point discussed the scales of measurement. Just as temperature may be measured in the mercury scale, the hydrogen scale, the platinum scale, and so on, it is possible to measure quantities like brightness on various scales.

The physicist will undoubtedly adopt the ordinary photometric luminosity scale for all colorimetric purposes in which instrumental measurement is required. On the other hand, other scales more nearly related to psychological experience, but still essentially arbitrary, will be far more valuable in the preparation of colour charts, as Ostwald points out.

The nomenclature of Ostwald [4] seems at first somewhat different. He is concerned only with body colours having reflection coefficients between 0 and 1. A grey reflects a fraction w of the incident white light as compared with a quantity 1 reflected by a perfectly reflecting and diffusing surface. The other portion s is absorbed ; then $w+s=1$, where w can be called the white content and s the black content of the grey. Ostwald adopts a scale of greys in which the white contents vary geometrically ; these are called a, b, c, d, etc.

In the case of a colour showing hue, the reflected portion is divisible into two parts, v due to the pure hue and w to more or less white. Hence the equation above becomes $v+w+s=1$. w and s are the white and black contents as before. Colour is specified by its dominant hue and its contents of "full colour" (Vollfarbe), and white. Ostwald criticises Helmholtz for not realising that the "black content" is an essential factor in the appearance of a surface in an ordinary case where colour contrasts are manifest in the field of vision, but Helmholtz was concerned only with the variation of the elements of sensation, and his employment of the term "Helligkeit," signifying absolute light strength, was therefore quite correct while a single sensation was discussed apart from contrast effects. Ostwald's system has been employed in his "Farbenatlas," which gives 2500 indexed colours. A system of colour measurement has also been developed.

While the report of the Colorimetry Committee has put psychological nomenclature in order, the physicist will feel that the use of terms such as white, grey, and the like in fundamental definitions is highly unsatisfactory. For purposes of colorimetry psycho-physical measurements are necessary, and it seems necessary to choose units and formulate definitions which, although possibly arbitrary, are founded securely in physical facts wherever this is possible. In thinking over the matter for the purposes of the book to which reference was made, it appeared to the present writer that the only way to discuss a sensation for purposes of measurement is by reference to an arbitrary physical stimulus which evokes this sensation (or something near it) in the normal subject. Hence white was defined by reference to the colour of sunlight, an arbitrary but definite step. The alternative is the adoption of the results of such lengthy statistical work as that of Priest on "the spectral distribution of energy required to evoke the grey sensation" (Bureau of Standards, Scientific Papers, No. 417). The term "brightness" can be given its usual photometric significance, but there is still the difficulty of finding a suitable term for the relative brightness of a diffusely reflecting surface. It seemed that the term brilliance suggested by the American report gave the term required.

Since the issue of the book, this step has been criticised on the ground that the intent of the American definition of the term brilliance is to exclude the idea of a quantity specified or measurable by any reference to stimuli. Certainly if this appropriation of the term is of importance to psychology, physicists must agree upon some other word such as luminosity or value when dealing with body-colour measurement ; but unfortunately the multiplication of terms for identical mental concepts is quite likely to lead to the confusion which the report seeks to avoid. The present writer prefers the careful use of *one* word provided that the manner of its use is indicated, just as is necessary in the case of terms like "temperature" and "distance," which themselves carry no implied reference to any special mode of physical measurement, but are in perfectly arbitrary use in physics. The question needs more discussion before it is finally settled, but the whole matter is of great importance for purposes of colour standardisation and measurement. Until matters are definitely settled we might do far worse than follow Abney in the non-committal terminology mentioned above.

[3] The *Illuminating Engineer*, Vol. xv. No. 8, p. 227. The definition of "brightness" is given there, but "luminosity" is not defined in British practice. Colloquially, it refers to self-luminous surfaces. The American report says: "*Relative* light quantities are called *luminosities*."

[4] For a concise statement of Ostwald's theory see "Die Grundlage der messenden Farbenlehre." (Barth, Leipzig, 1921.)

The Trend of Development of Marine-Propelling Machinery.

THE eleventh Thomas Hawksley lecture was read before the Institution of Mechanical Engineers on Friday, November 7, by Engineer Vice-Admiral Sir George G. Goodwin, and dealt with the development of marine-propelling machinery. Whilst naval conditions impose restrictions on the design of machinery, both warships and vessels of the mercantile marine must possess the qualities in their machinery of reliability, endurance, durability, and economy, each in high degree. The best economical performances are generally obtained in the merchant service, where machinery is designed for economical running at steady speed. In warships, economy at full power is necessary in order to keep down the weight of the boiler installation; most of the steaming is done at powers so low as one-tenth, or less of full power, and economy at these low powers is also of great importance. Both desires cannot be met completely, and a compromise is arranged.

Marine-propelling machinery develops in warships by the striving for high power on low weight per horse-power, involving the development of high class and special materials, and by the concurrent aiming at the most economical running under very varying conditions. In merchant ships, where weight is allowed on a more generous scale, and steady running is the rule, the development is by the efforts to reduce fuel consumption and, so far as other conditions will allow, by arranging the design so as to enable the machinery to be manufactured, but manufactured properly, at low cost, and to be kept running efficiently with a low repair bill and other running costs.

At present none of the British surface fighting ships is propelled by reciprocating steam engines; these have disappeared entirely except in a few auxiliary vessels and non-fighting craft. All are now fitted with turbines, the later vessels being all-geared, that is, all the turbines in the ship are geared down to drive the propeller; there are now no partially geared turbines in the Navy.

Lloyd's Register Book for 1924–5 shows that the tonnage afloat is divided between the different types of propelling machinery as follows: steam reciprocating engines, 50,742,758 tons; steam turbines, 8,795,584 tons; motors, 1,975,798 tons. The percentage tonnages for five years is divided as follows:

Year.	Steam reciprocating, per cent.	Steam Turbines, per cent.	Motors, per cent.
1918–19	70	28	2
1919–20	57·4	30·7	1·9
1920–21	73·6	23·3	3·1
1921–22	56·4	34·6	9·0
1922–23	52·3	37·4	10·3

These figures show the preponderance of reciprocating engines in the mercantile marine, and that this type is still being built to a larger extent than all other types. But very little development is taking place in reciprocating machinery, and the ratio of tonnage fitted is a falling one. The engine has great advantages but also grave disadvantages. The anticipated better economical performances of the fast-running geared turbine and slow-running propeller have been realised and the direct driving turbine may be regarded as quite obsolescent for marine purposes, and indeed obsolete so far as manufacture is concerned, especially as the geared type lends itself to further improvement, which cannot be developed in the older type.

In a paper read before the Institution of Naval Architects in 1920, Engineer-Commander Tostevin states that there were then 600 sets of mechanical reduction gearing in service in the Navy. There had been trouble in a few cases only; six instances had occurred of fractured pinion teeth, and two of these had taken place during service and the others during trials before the receipt of the machinery by the Admiralty. Some of the later merchant ships have not been so fortunate, and several cases of cracked and fractured teeth have been reported. Facilities have been freely given all round to assist in the investigation of the behaviour of the gears in the merchant service as compared with those in the Navy, and although general agreement as to the cause has not been reached, the discussions have brought to light much valuable information. It may be noted that double-reduction gears were fitted in the merchant vessels where the mishaps occurred, whilst the Navy has generally single-reduction gears. Failure almost always occurred by fracture of the pinion teeth and rarely, if ever, by fracture or permanent deformation of the wheel teeth. No case of faulty or fractured gearing has been reported since April last, and confidence is being rapidly restored.

The inherent disadvantages of electric and hydraulic transmission have outweighed their known advantages, and these alternatives to mechanical gearing have not been adopted in this country.

There is a field for development in point of economy by increasing the temperature range by the adoption of higher boiler pressures, or higher superheat, or both. The steam turbine is specially suitable for both, or either. Whether we are yet ready for the adoption of materially higher boiler pressures afloat is a little problematic; past experience calls for caution, but the matter is receiving consideration. In the merchant service the benefit of superheating has been realised to a greater extent than in the Navy. A recent trial under normal sea-going conditions of a single screw ship with all-geared turbines of 3000 shaft-horse-power, with steam at the high-pressure first expansion of 165 lb. per sq. in. and 200° F. superheat, with exhaust pressure of 28¼ inches, gave a steam consumption for the turbines only of just over 9 lb. per shaft-horse-power per hour. Sir Charles Parsons states that the consumption should be about 8 lb. in the case quoted, hence there is still scope for improvement.

Sir George Goodwin also reminds us that development in one respect must be accompanied by developments in other respects, and cites the development of the single-collar thrust block in time to take the thrust from a geared turbine installation of 38,000 shaft-horse-power passing through a single shaft.

Auxiliary machinery and motor propulsion machinery were also dealt with in the lecture. There are two recent ventures of interest: (1) A combination of

heavy oil engines with electric transmission. (2) The transmission of the power of a fast-running heavy oil engine through mechanical gearing.

Sir George Goodwin has come to some conclusions regarding the future. These are as follows:

(1) The reciprocating steam engine will be the most common type in the mercantile marine for some years yet. It is not likely to be developed in power, and not in economy of fuel consumption to any marked degree.

(2) Geared steam turbines must continue to be the engine for all ships of high power, as in the Navy. Its development will be in the direction of improving its fuel consumption by use of superheated steam and by attention to its details and auxiliary machinery.

(3) The heavy oil engine, having established its reputation for reliability, will, having regard to its low fuel consumption per horse-power, be the propelling engine of an increasing number of cargo ships and ships of low and moderate power, but its rate of increase of use will be retarded while its cost remains high, and efforts will be made to reduce the cost by increasing the power per cylinder by the several stages leading to the double-acting two stroke cycle engine.

Development will require a great deal of engineering research and experimental work, and also probably fundamental research in certain branches of pure science. Co-ordination in the different fields of research and with the engineer has been accomplished in some branches of engineering in the United States, and Sir George Goodwin invites attention to the system adopted of having an intermediate laboratory separate from the fundamental research station and separate from the factory. Here the results of fundamental research are collected and sifted, and the parts promising to be of service to the engineer are co-ordinated and developed with the help of engineers who know the needs of the factory, and also with the help of others who are expert in the economical side. The results are said to be satisfactory and to justify the cost.

Dielectric Mineral Separation.

By Prof. S. J. TRUSCOTT.

IN the preparation of clean mineral from crude ore, the processes of water concentration and flotation concentration, in combination or separately, achieve all that is required with sulphide ores, the former process being particularly successful in the recovery of coarse and granular mineral, while flotation is equally successful with fine and with the finest mineral. But, with oxide or oxidised ores, though water concentration will generally suffice where the mineral grain is large and remains so during crushing, there is no equivalent of flotation to recover fine mineral or that so fine as to go into suspension. Yet in the dressing of tin and other oxide ores requiring fine crushing, a substantial proportion of the ore passes into the fine condition described as slime, from which it is at present impossible to make a satisfactory mineral recovery. Again, the recovery of the vanadium mica, roscoelite, from the sandstone in which it occurs typically in the United States is not at present possible by any dressing process, because the roscoelite is friable and light; such vanadium deposits, large as they are, at present lie idle. Even where the mineral grain is sufficiently large it sometimes happens, and particularly with minerals of the rare metals, that water concentration will yield a complex concentrate of two or more minerals with properties of density, magnetic permeability, electric conductivity, etc., so similar that no one of the presently applied methods of dressing is effective in separation. Thus, some vanadium, uranium, and molybdenum minerals occurring together largely remain inseparable; and some alluvial tin concentrates contain rare minerals from which it is difficult to free the tin.

Given this position, any new process based upon physical differences between minerals not yet used in dressing, and disclosing possibilities of useful application in the field as yet unoccupied, is welcome. Dr. H. S. Hatfield, in a paper read before the Institution of Mining and Metallurgy in February last, brought forward such a process, one based on the differences in inductive capacity between minerals and one which he termed "dielectric mineral separation," substances being dielectrics by virtue of their property to propagate electric forces through themselves by induction. The "specific inductive capacity" may be considered to be a particular range of the more general "dielectric constant." Conductors may be considered to have an infinitely high dielectric constant; but insulators are the characteristic dielectrics.

As groups, the sulphide ore-minerals are conductors, the oxide ore-minerals poor conductors, and the gangue minerals are non-conductors. Actually, the oxide ore-minerals have dielectric constants of the order of 20-30, while the constants of the gangue minerals are of the order of 5, that of air being unity. Situated in an electric field in air, the forces acting on particles of ore are such that all would be attracted to the electrode with forces so much of the same order that gangue and mineral could not be differentiated. The position is different in a magnetic field, in that gangue minerals have a magnetic permeability practically the same as that of air and accordingly behave as non-magnetics. In dielectric separation there are no non-electrics comparable to the non-magnetics of magnetic separation.

Dielectric separation therefore employs a liquid dielectric having a constant intermediate between that of the gangue and that of the mineral, in which medium the gangue is repelled and the mineral attracted to the electrodes. Water is useless, because when pure its dielectric constant is too high, and when impure it becomes a conductor. Dr. Hatfield has chosen to mix kerosene and nitrobenzene in proportions such as in each case give the desired constant, that of kerosene being about 2 and that of nitrobenzene about 36.

The necessary electric field is obtained by a single-phase alternating current of about 200 volts and 150 frequency, brought to electrodes about a couple of millimetres apart. These electrodes may be parallel wires, or one wire coiled around a straight wire, or

points on parallel plates. With the field in being and the crushed ore passing, the mineral is held while the gangue falls through. When loaded the circuit is broken and the mineral drops. Conducting minerals are rendered innocuous by covering one electrode with paper.

There is difficulty in this process in that the dielectric constant of a mineral is liable to vary according to its previous treatment in crushing and in exposure; it varies also with the frequency: these are points upon which careful work is necessary. There is also economic difficulty in recovering the expensive medium which passes out both with the mineral and with the gangue, these two products having to be filter-pressed and then subjected to heat to distil the remaining liquid. It is claimed that a similar difficulty has been successfully met in removing sulphur from kerosene with added colloidal silica, the silica being recovered dry and in a condition to be used again.

The process differs, on one hand, from ordinary electrostatic mineral separation in that it is not operative by reason of charges acquired by contact, and, on the other hand, from cataphoresis in that this latter is a migration of particles towards an electrode by reason of charges they possess of themselves. In dielectric separation there is no question of electric charges; the particle in the electric field is in an analogous position to ore in a magnetic field, only that there is both attraction and repulsion in dielectric separation, whereas with magnetic separation there is rather differential attraction, magnetic repulsion being a rare phenomenon.

Obituary.

Sir Maurice Fitzmaurice, C.M.G., F.R.S.

BY the death of Sir Maurice Fitzmaurice on November 17, the engineering world has lost a leader of outstanding ability who served the country in many capacities and whose name will always be associated with two great undertakings, the construction of the Assouan Dam on the Nile and the extension of the main drainage of London. He was also associated with railway development and harbour and dock work in various parts of the world. In 1916 he was chosen to succeed Mr. Alexander Ross as president of the Institution of Civil Engineers, from which he received the Telford and Watt Gold Medals, and three years later he was admitted a fellow of the Royal Society, a distinction also conferred upon many of his predecessors such as Telford, Walker, Sir Benjamin Baker, Rennie, Hawkshaw, Robert Stephenson, and Sir William Preece.

The son of Dr. Robert Fitzmaurice of Cloghers, Tralee, Sir Maurice Fitzmaurice was born in Co. Kerry on May 11, 1861. At Trinity College, Dublin, which has possessed a school of engineering since 1847 and where for thirty years Samuel Downing occupied the chair of engineering, he took the degrees of M.A. and Master of Engineering, and then became articled to Sir Benjamin Baker, who at that time was engaged with Sir John Fowler on the Forth Bridge. This was the first great work with which Sir Maurice was associated. During the 'nineties he was in charge of construction work in Canada and elsewhere, and then in 1898, at the age of thirty-eight, he received the important appointment of Chief Engineer to the Egyptian Government for the construction of the great Assouan Dam, with which Sir William Willcocks, Sir Benjamin Baker, and Sir John Aird were associated. This Dam, once described as "one of the grandest engineering undertakings of our time," is 6400 feet long, has 180 sluices, and contains more than 1,000,000 tons of granite. Begun in 1898, it was completed in 1902, Sir Maurice's work being recognised by the award of the C.M.G.

Returning home, Sir Maurice was appointed successor to Sir Alexander Binnie as Chief Engineer of the London County Council. In this capacity, he was responsible for the construction of the Rotherhithe Tunnel, the Embankment in front of the new County Hall, the new Vauxhall Bridge, and the subway for trams under Aldwych and Kingsway to the Embankment. During his period of office, 1902–1912, he also carried through the duplication and extension of the whole drainage system of London at a cost of about 4,000,000*l*. Until 1847 the sewage of London was discharged direct into the Thames, and it was under one of Sir Maurice's predecessors, Sir John Bazalgette, that the great sewers were carried down to Barking and Cross Ness, and in Sir Maurice's report to the Council in 1912 will be found many details of the growth of the wonderful network of sewers which carry off the drainage of London and the methods used for its disposal.

During the latter part of his career, Sir Maurice was a partner in the firm of Coode, Fitzmaurice, Wilson and Mitchell, consulting engineers to the Crown Colonies and to the Sudan Government for the Blue Nile Irrigation Works, and chief engineers of the national harbours at Dover and Peterhead. He also acted as chairman for important committees appointed by the Admiralty, War Office, Foreign Office, and Board of Trade; on two occasions he visited the British front in Flanders to advise on questions of drainage, and served on the International Technical Commission of the Suez Canal. Knighted in 1912, Sir Maurice received many honours, among which was the honorary membership of the American Society of Civil Engineers. He was the author of works on bridges and drainage, while his presidential address to the Institution of Civil Engineers contains much valuable advice to young engineers, the results of his own experience. "In looking back," he said, "over the great number of engineers whom I have come across in works and in office, I cannot bring to mind any case of a hard worker who has really failed."

We regret to announce the following deaths:

Mr. Romeyn B. Hough, author of the "Handbook of Trees of the Northern United States and Canada," who was known also for his remarkable fascicles of sections of North American woods, aged sixty-seven.

Dr. E. König, of the photographic department of the dye-works of Meister, Lucius and Bruning, Höchst-am-Main, whose name is known in connexion with the pinatype process, and with sensitisers and desensitisers, on October 29, aged fifty-four.

Current Topics and Events.

IT is of interest to recall that the date November 23 marks the 260th anniversary of the publication in 1664 of that rare and notable folio by Robert Hooke, entitled "Micrographia: or some Physiological Descriptions of Minute Bodies made by Magnifying Glasses, with Observations and Inquiries thereupon." The issue was licensed by Viscount Brouncker, P.R.S. Hooke, who was born in 1635, at Freshwater, Isle of Wight, died in 1703. He was associated in intimate fashion with the early founders of the Royal Society—Moray, Wren, Boyle, Evelyn, and others—and worked with amazing industry to promote its aims. The lineaments of this remarkable man have not been bequeathed to posterity, since no authentic portrait of him exists. Sir Robert Moray had originally suggested Hooke, in 1662, as a curator of experiments to the Royal Society, putting it that "Mr. Hooke should come and sit amongst them," but it was not until November 23, 1664, that the president was desired to declare to the whole Society that the council thought good to have a curator by office, and Dr. Wilkins was deputed to submit that "Mr. Hooke standing for a curator's place be this afternoon nominated." Robert Boyle was thanked for dispensing with his services, in favour of the Society.

THE "Micrographia" contains a dedication to the King, this subscribing to the current flamboyant style. "There are, Sir" (Hooke says) "several other of your Subjects, of your Royal Society, now busie about Nobler Matters: The Improvement of Manufactures and Agriculture, the Increase of Commerce, the Advantages of Navigation: In all which they are assisted by your Majestie's Incouragement and Example. Amidst all those greater Designs, I have presumed to bring in that which is more proportionable to the smalness of my Abilities, and to offer some of the least of all visible things, to that Mighty King that has established an Empire over the best of all Invisible things of the World, the Minds of Men." The Royal Society is given a special dedication, Hooke informing them that "the Rules you have prescrib'd yourselves in your Philosophical Progress do seem the best that have ever yet been practis'd. And particularly that of avoiding Dogmatizing." A long and somewhat drawn-out preface to the reader follows. Of Wren and Wilkins, Hooke has much to say in eulogy and evident friendship. There scarce ever met, he affirms, in one man (Wren) so great a perfection, such a mechanical hand, and so philosophical a mind.

BORROWING the title of a world-known story, "A Tale of Two Cities," Mr. H. S. Pritchett discusses in the November issue of *Scribner's Magazine* the application and function of Benjamin Franklin's trust for the cities of Boston and Philadelphia, the provisions of which were set forth in a codicil to his will made some eight months prior to his death. The recent celebration of the centenary of the Franklin Institute of Philadelphia gives the article special point. The detailed information respecting Franklin's philanthropic foundation is, indeed, welcome and timely. Needless to say, two other cities hold Franklin in honoured remembrance. He lived in London eleven years, was elected a fellow of the Royal Society, and served on its council. The Society would take no fees from him. The Paris National Assembly wore a badge of mourning for three days after his death; Condorcet pronounced a eulogy before the Academy of Sciences. Franklin's design was to benefit Boston and Philadelphia through the creation of a money trust for each, which, however, contained at the same time a hard and fast plan, operative for one hundred years, with a contingent second centennial period. He wished to form the mind of youth and conduce to the material prosperity of youth; also to encourage the projection of works of public utility of such nature as might lead to the comfort and convenience of the inhabitants of the cities named. Without stretch of imagination he would seem to have preceded Mr. Carnegie and Mr. Rockefeller. The story of these bequests, their limitations, the difficulties encountered in their administration, and, not least, the economic and social changes which have affected them, form, in the hands of Mr. Pritchett, an interesting record, throwing as they do much light upon the question of the institution, management, and obligations which arise therefrom.

ELECTRIC supply authorities are sometimes required to give a supply of electricity to districts at a great distance from the generating station, although the probable demand is small. In these cases it does not pay them to erect a manually operated substation, and a completely automatic substation is too expensive. Mr. Chattock, the electrical engineer to Birmingham, deserves great credit for doing valuable pioneering work with small automatic substations equipped with mercury vapour rectifiers of the glass-bulb type. This apparatus statically transforms alternating current into direct current. When a mercury arc exists in a vacuum under certain temperature conditions, it acts like a valve, allowing current to flow through it in one direction and not in the other. The cathode bath of mercury is the positive pole of the direct-current circuit. If the vacuum fail for any reason, then a violent short circuit occurs, but luckily this rarely happens. In a paper read to the Institution of Electrical Engineers on November 20, Mr. Rogers stated that in the case of glass bulbs for 230 volts, no single instance in his experience of a short circuit has occurred. This paper will be of immediate value to engineers, as not only are the arrangements for the automatic control of these rectifiers given in full, but also schedules of the complete costs of rectifier substations. A method is given in the appendix of supplying direct current at 550 volts to a six-mile length of double tramway track by means of semi-automatic rectifier substations. The method is both simple and cheap, and probably will have applications in the immediate future.

THE decision of the editors of the *Irish Naturalist* to cease publication of this journal with the December number will be learned with deep regret by the many readers in Great Britain and elsewhere who have followed the admirable work done by the magazine in promoting the study of the fauna of Ireland for a period of thirty-three years. It has been unable to recover from the vicissitudes due to the War, and increased costs of production, with the loss by death or otherwise of a large body of its former supporters, have combined to render continued publication impossible. An author index to the last eight volumes, on the same lines as that for the first twenty-five, will be issued with the concluding number of the current volume. A subject index and title index to the whole series is contemplated if sufficient financial support is forthcoming.

THE remarkable and well-known collection of stone implements and other Irish antiquities formed by Mr. W. J. Knowles of Flixton Place, Ballymena, Ireland, was sold by auction at Sotheby's on November 17 and three following days, the total amount realised being 4005*l*. The more important stone implements were purchased for the Belfast Museum, including a fine kite-shaped lance-head of flint found between Bellaghy and Castle Dawson (25*l*.), one of gray flint polished on both sides, 6 inches long, from Tyhorney (25*l*.), a spear-head of elongated kite-form, 7½ inches, from Carndon (10*l*.), chipped axe of basalt, 13 inches long, found at Armoy (10*l*.). Several of these implements were figured in the Journal of the Royal Anthropological Institute, vol. xxxiii. The Ashmolean Museum obtained two rare pieces—a cauldron of thin sheet bronze formed of four riveted plates found near Portglenoue (50*l*.), and a heart-shaped bronze fibula with triangular plate of the second century A.D. (17*l*. 10*s*.). A Celtic quadrangular iron bell with clapper fell to Belfast Museum (25*l*.).

FEW educational organisations have done more valuable work than has the School Nature Study Union, which celebrated its coming of age in September last. Founded in 1903 by a small band of enthusiasts, of whom the leaders were Miss Kate Hall and the Rev. Claude Hinscliff, with the primary object of bringing a breath of the country into the drear and drab lives of the children of the London slums, it has grown into a large and vigorous organisation permeating the educational system of the whole of England, endeavouring to foster in children a real love of the natural world around them, an appreciation of its beauty, and an interest in its manifold workings. The special anniversary number of its official organ, *School Nature Study*, issued to commemorate its coming of age, contains much interesting matter on various aspects of nature study, and a review of the growth of the Union and of the work that has been accomplished. Three articles deserve special notice. Prof. J. Arthur Thomson has rewritten his pamphlet on "The True Inwardness of Nature Study," and, in its revised form, it is worthy of the close attention of all who desire to see an extended system of biological teaching put into practice. It is a clear and reasoned statement of the objects, methods, difficulties, and potentialities of nature study, and embodies the ideals of the Union for which it was written.

THE other two articles in this anniversary issue of *School Nature Study*, by the president of the Union, Dr. Chalmers Mitchell, on "Observation and Theory," and Prof. J. B. Farmer on "Teleology in Nature," bear on the same problem and also contain timely warning against one of the greatest dangers of nature study in inexperienced hands, namely, the attempt to interpret the facts observed, the tendency to warp the powers of observation through the influence of preconceived theories, and the interpretation of animal and plant behaviour on anthropomorphic lines. Dr. Chalmers Mitchell deals with the general problem; Prof. Farmer is concerned mainly with the dangers of teleology, the appeal to design or purpose as an explanation of structure or behaviour. For these friendly warnings, so timely given, the Union and its supporters should be grateful. We join in the many congratulations which the Union has received on this special anniversary of its foundation. With the ideals before it so high, with the enthusiasm of its executive so keen and whole-hearted, and with a growing volume of support from biologists on one hand and educationists on the other, the Union in its maturity should bring to fruition the seeds so diligently sown in its infancy and adolescence.

A CHADWICK public lecture on "Smoke: its Cause, Nature, Effects and Methods of Prevention" was delivered by Prof. J. B. Cohen on Wednesday, November 19. Prof. Cohen stated that soot from factory chimneys is very different in character from that from domestic fireplaces where raw coal is burnt. In the former case, owing to the high temperature and strong draught, the volatile portions of the coal are mainly consumed, whilst the draught carries off mechanically fine mineral dust and grit mixed with carbon containing little tar. Domestic soot, on the other hand, may contain as much as a quarter of its weight of tar. It is this tar which causes the soot to cling, accumulating with time and blackening surfaces with a varnish which is not removed by rain. Vegetation suffers in several ways from the presence of smoke. If the light is partially cut off by the pall of smoke, or if the leaf (more especially of evergreens) is blackened by a coating of soot, or again if the stomata are blocked with tar, the plant must suffer. Again, the plant is affected by the acid soot, and also by the sulphur acids which pass into the air from burning coal and are washed down by rain. The effect of this acid is to corrode the leaf, which withers and falls much earlier in and near a town than in the country. Moreover, the acid percolating through the soil destroys certain organisms and enzymes concerned in the assimilation of the soil constituents, and many grasses, vegetables and flowering plants succumb. Even the colour of flowers is affected. The observations of Sir Frank Baines have also made it evident that the sulphur acids from coal attack masonry, while fabrics,

leather bindings and metal work are being similarly attacked. Passing to remedial measures, Prof. Cohen stated that in his opinion the situation could be much improved by the production of cheaper gas, coke, and electricity, while local authorities should encourage their sale and exercise to the full their powers under the Public Health Act of 1875 to stop unnecessary smoke from boiler chimneys.

THE opening meeting of the Illuminating Engineering Society on November 18 was, by custom, devoted to reports of progress and the exhibition of novelties. Mr. Leon Gaster in his opening address remarked that the vacation had been a period of exceptional activity. Illumination had been dealt with at the World Power Conference, the meetings of the International Illumination Commission and the International Conference on Industrial Hygiene in Geneva, and at the Conference afterwards arranged by the Society at the British Empire Exhibition. At Geneva an excellent opportunity of interesting hygienists in lighting problems had been presented, and good lighting is now definitely accepted as an element indispensable for health, safety, and efficiency. Developments abroad had been rapid, and in the present year an Illuminating Engineering Society had been formed in Austria. A report presented by the Committee on Progress in Electric Lamps and Lighting Appliances directed attention to the steady advance towards higher values of illumination, and quoted examples of the general tendency to utilise light in a more scientific manner. The exhibits after the meeting as usual covered a wide range, including new reflectors and luminous signs, and a motor-car headlight specially designed to overcome the dazzle difficulty. Mr. W. G. Raffe dealt with the psychology of illumination, and Miss Mary Wurm gave an address on stage lighting in connexion with music, illustrating her remarks by experiences in various Continental theatres.

IN the unavoidable absence of Lord Weir, Mr. H. B. Weeks presided at the third annual meeting of the Cast Iron Research Association in London on November 19. The chairman laid stress on the great progress made during the year, and summarised the main developments, referring particularly to the extended research programme and the establishment of a laboratory. Sir John Dewrance was elected president of the Association for the period 1924–26, and the following were elected vice-presidents: Mr. Geo. Pate (Falkirk), Mr. Summers Hunter (Wallsend-on-Tyne), Mr. F. W. Firth (Sheffield), Mr. C. E. Lloyd (Dudley), and Mr. W. B. M. Jackson (Chesterfield). Commander C. W. Craven and Prof. T. Turner were re-elected vice-presidents. A great tribute was paid to the services rendered to the Association by the retiring president, the Rt. Hon. Lord Weir of Eastwood, who was elected an honorary member. Mr. A. J. Burn, Mr. F. J. Cook, Mr. T. Donaldson, Mr. N. B. Ellington, Mr. J. Haigh, Major C. Howl, and Mr. M. Riddell were re-elected to the council. Dr. W. Rosenhain and Prof. T. Turner were elected honorary members, and Dr. Rosenhain spoke, expressing the hope that there would be even greater co-operation in future between the Association and the Ferrous Alloys Research Committee. Delegates nominated by the leading technical institutions were also elected at the meeting.

THE next Congress of the Royal Sanitary Institute and Health Exhibition will be held at Edinburgh on July 20-25, 1925, by invitation of the Magistrates and City Council.

THE following have been elected officers of the Cambridge Philosophical Society for the session 1924–1925: *President*, Prof. J. T. Wilson; *Vice-Presidents*, Prof. J. Barcroft, Mr. C. T. Heycock, Dr. G. T. Bennett; *Treasurer*, Mr. F. A. Potts; *Secretaries*, Dr. F. W. Aston, Mr. J. Gray, Mr. F. P. White; *New Members of the Council*, Dr. A. B. Appleton, Dr. C. D. Ellis, Mr. F. F. Blackman, Mr. C. T. R. Wilson, Mr. J. E. Littlewood, Mr. G. Udny Yule, Prof. E. A. Milne.

THE *Chemiker Zeitung* reports that Prof. F. Paschen, formerly director of the Physical Institute of the University of Tübingen, was installed on November 1 as president of the Physikalisch-Technische Anstalt, Berlin. The same issue also records the appointment of Herr Geheimrat Wiedfeldt, German Ambassador to Washington, to the head of the directorate of the firm of Krupp in Essen-Ruhr. Dr. Bruhn retires from the board of directors, in order to become the representative of Krupps in Berlin, in succession to Dr. Kurt Sorge, who has resigned.

A NEW expedition to the Arctic is being planned by Mr. Lauge Koch, the Danish explorer. According to the *Geographical Journal* for November, the objects will be mainly geographical and cartographical, and the field of work will be Grant Land and other islands of Arctic Canada, where Mr. Koch proposes to investigate and map the mountain range which he believes to be a continuation of those he explored in Northern Greenland and a section of a great arc that continues through Spitsbergen, the Shetlands, Scotland, and Wales. No date for the departure of the expedition has yet been fixed.

THE Royal Geographical Society, in conjunction with the University of London, has arranged a meeting of a special character to be held at the Central Hall, Westminster, on December 1. M. Albert Kahn, who is already well known for the establishment of the Albert Kahn Travelling Fellowships and similar works for the promotion of international comity, is sending to the meeting a number of photographs taken in natural colours by his direction in various parts of the world. These will be projected on a screen in four groups illustrating European scenery, the relation of environment to man, modern architecture, and China, and will be described by Mr. A. Ogilvie, Mr. L. H. Dudley-Buxton, Mr. E. A. Benians, and Prof. P. M. Roxby, all of whom have held Albert Kahn Travelling Fellowships.

WE learn from *Science* that an Institute of Research has been established by Lehigh University, Bethlehem, Pennsylvania, "to encourage and promote scientific

research and scholarly achievement in every division of learning represented in the organisation of the university; and in recognition of the need for further and more exact knowledge in science and in the applications of science to the affairs of modern life." The Institute will be controlled by an executive board including heads of the faculties of Lehigh University, and it is hoped to afford training in research methods to the staff of the University and the Institute, to graduate students of the former, and to special investigators. The New Jersey Zinc Company has already founded a research fellowship in science and technology in the new Institute. Bulletins or reports on the progress made in problems attacked will be issued from time to time.

MESSRS. Dulau and Co., Ltd., 34 Margaret Street, W.1, have just circulated their Catalogue No. 119, giving the titles of some 1400 second-hand books and serials relating to astronomy, dialling, meteorology, aviation, physics and chemistry, mathematics and mechanics, and fen drainage, which they have for sale.

THE Cambridge University Press announce for early publication "A History of British Earthquakes," by Dr. C. Davison, the aim of which is to record all known British earthquakes, to trace the zones in which crust-changes have recently occurred and in which the faults are yet alive, and to discover some of the laws that rule the growth of faults.

THE Cantor Lectures on "Colloid Chemistry," which were given by Dr. E. K. Rideal at the beginning of the year, have been published in three recent numbers of the Journal of the Royal Society of Arts (Oct. 17, 24, and 31). Dr. Rideal's review included such topics as adsorption, methods of preparation, stability of sols, emulsions, soaps, etc., practical applications of the features discussed being frequently given.

THE Oxford University Press will publish at the beginning of December a limited edition of "The History of Aeronautics in Great Britain from the earliest period to the latter half of the Nineteenth Century," by J. E. Hodgson. The work will include chapters on the development of international aeronautics, an annotated list of papers read before the Aeronautical (now the Royal Aeronautical) Society between 1866–93, and a selected bibliography.

Our Astronomical Column.

A STUDY OF STELLAR MOTIONS.—The *Scientific Monthly* for November contains an interesting analysis of stellar velocities by Dr. Gustaf Strömberg. He forms *velocity surfaces* for different groups of stars by imagining the bodies forming a group to start from a common point at the same instant; then after moving each with their proper speed for the selected unit of time, the curve or surface drawn through them gives a graphic representation of the velocity distribution.

These surfaces in most cases are considerably elongated not only in sections perpendicular to the galactic plane (which we might foresee *a priori*) but in the galactic plane itself. This is so far in accord with Schwarzschild's ellipsoidal hypothesis, but a considerable deviation from such a symmetrical form is found, which is especially notable when stars of high velocity, more than 100 km./sec., are examined. They are found to be practically all moving towards one hemisphere. A similar want of symmetry is found in many other distant objects.

The author gives a tentative explanation, supposing that some fundamental system of reference exists in space, and that high velocities relatively to it are far more rare than small velocities. He gives an illustration; supposing a ship moving rapidly through the air, then various classes of objects on deck are variously affected by the strong draught produced, some moving with the ship, others keeping their position in the air, while others have intermediate motions. If several ships are postulated, a close resemblance to the observed stellar motions would arise. The paper closes with some discussion on the bearings of these results on Einstein's general theory of relativity.

MARTIAN PHOTOGRAPHY.—Two very interesting series of Martian photographs are reproduced and discussed in the October number of Publications of the Astronomical Society of the Pacific. The first, by W. H. Wright, deals with photographs taken with the Crossley reflector at the Lick Observatory in light of three different wave-lengths, (1) ultra-violet, (2) yellow, and (3) infra-red. (1) shows no detail on the disc except the polar cap, and gives a distinctly larger image than the others; (2) agrees with the visual aspect of the planet; (3) shows the dusky regions in an accentuated manner, the polar cap being small and faint. (1) is thought to give a picture of the Martian atmosphere, extending 120 miles above the limb (this is supported by some recent observations of the occultation of Mars, a glow being seen for a few seconds after the disappearance of the disc). It is concluded that the polar cap is mainly an atmospheric phenomenon, but that there is probably a less conspicuous surface cap below it. The darkness of the dusky areas in (3) indicates that their radiations are mainly in the blue and green, agreeing with their visual aspect. Terrestrial landscapes taken from Mt. Hamilton with (1) and (3) show that the distant landscape is wholly blotted out in (1) by the atmospheric veil, while it is clearly visible in (3).

The second series was made by Prof. E. C. Slipher at Flagstaff, with the 24-inch refractor and the 40-inch reflector. The tests with light of different wave-lengths are in full accord with those of Mr. Wright. The pictures are grouped in a manner to bring out the seasonal changes, the dusky areas darkening in the late spring and fading in the autumn; this is in full accord with the vegetation hypothesis. On the whole, these markings and the polar cap have repeated the cycle of change recorded in 1909, the region Deucalion being, however, fainter this year.

Search was made, without success, for the chlorophyl bands in the spectrum of the dusky areas. It is noted that it is much more difficult to detect these in reflected light than in transmitted light.

Prof. R. Trumpler also publishes some simultaneous drawings and photographs made with the 36-inch Lick refractor. The drawings show numerous canals, including some in the dusky areas; traces of several of these can be seen in the photographic reproductions, and the original negatives are stated to show many more. The polar cap had some dark bands across it, and detached white patches at its edges. A small white spot is shown in the middle of Auroræ Sinus, not very far from "Dawes Ice Island."

Research Items.

HOLY WAYS AND HOLY PLACES.—Prof. H. J. Fleure has published in the *Sociological Review* a communication to the Conference on Living Religions, recently held at Wembley, on the origin of sites which are or have been held in special veneration as centres of religious cults. Such centres have to a great extent grown up along routes of trade and intercourse such as can be traced so far back, at least, as the late neolithic and early metal ages. There is evidence for the spread of cultural influences between the Iberian Peninsula, France, western Britain and Ireland, southern Sweden, Denmark, and north-west Germany. The megalithic monuments which mark this spread of culture may well have been stations of men of superior culture to which natives would come to trade, their sanctity continuing down to historic times, as is shown by the records of the early Christian Church. The stations along the route followed by Abram from Haran through Palestine—Shechem, Bethel, Hebron, and Beersheba—gathered traditions of sanctity in course of time. Mecca, a station of sanctity far older than Islam, as is shown by the cult of the Black Stone, is a place of contact on the trade way from Arabia Felix northward. Santiago de Compostella is a focus behind alternative ports going back directly and indirectly to the earlier stone monuments. Similarly St. Davids in South Wales, Canterbury, and possibly St. Andrews, each acted as a focus for sea routes; while Kief analogously is the culture entry for the land and rivers both from the south, by which Byzantine influence reached Muscovy, and from the west. Jerusalem originally was the fortress controlling the trade routes, whether from Hebron to Bethel and Shechem, to Jericho and across the Jordan, or along the western side of the Dead Sea.

GROWTH OF CHINESE.—Dr. S. M. Shirokogoroff and Dr. V. B. Appleton have published in the *Chinese Medical Journal* for May last an analysis of measurements of Chinese children and adolescents ranging in age from three years to twenty in the case of males and eighteen for females. The data investigated cover stature, weight, and growth, and are derived from 873 males and 266 females. It was at once apparent that the growth of females is not the same as males. There is, in the case of males, a regularity in increase of stature, weight, and relative weight. In females this regularity is disturbed at the age of 4 and 17 years in relative weight and at 18 in stature. There seem to be two critical periods in the development of males, at the age of 6 years and 15 years, when the absolute growth is evidently accelerated. The average stature of the Chinese is about 64·5 inches for males. Hence it appears that male stature growth stops at about 21 years. The curve of weight mounts smoothly up to about 17 years, when it nearly stops. For females the growth of stature stops almost completely at 15 and completely at 18. Though no data of adult females are available, the average stature is probably about 60 inches. In weight, the starting weight is as much as 2·5 pounds less than the males, and the growth almost ceases at 15 years.

KEMP FIBRES IN THE MERINO SHEEP.—Prof. Duerden and Miss Ritchie (Union of South Africa, Department of Agriculture, Science Bulletin No. 34) have made investigations into the nature of kemp fibres in the wool of sheep. These are straight, coarse, dull, opaque-white fibres, very brittle and inelastic, and not dyeing like wool fibres in the process of manufacture. Their presence in wool depreciates its value considerably, since it leads to lack of uniformity in texture and colour. The authors find that kemp fibres have a thick central medulla, with hollow interspaces containing inclusions of air, whereas wool fibres are solid, with no medulla and no air inclusions. Their experiments prove that kemp fibres dye just as readily as wool fibres, but that the air inclusions interfere with the effectiveness of the dye, and that the want of uniformity in colour is therefore purely an optical effect. They conclude that kemp fibres represent all that remains of the outer of the two coats of hair which the ancestor of the merino sheep, in common with most mammals, possessed. Under domestication this outer coat has largely disappeared as a result of long selective breeding and the inner coat, wool, alone remains. It is suggested that kemp fibres may be completely eliminated from the fleece of the merino sheep by an intensification of selective breeding and, alternatively, that it may be found possible by experiment to introduce some method for removing all the air from kemp fibres at one stage or other of the dyeing process and thereby secure uniformity of colour.

A GIANT INFLORESCENCE.—The *Gardener's Chronicle* for November 1 contains some very good photographs showing the development of the inflorescence of *Amorphophallus Titanum*, Beccari, in the Botanic Gardens at Buitenzorg, Java, Mr. P. Dakkus, the curator, having recorded in this manner the development of spathe and spadix from bud to maturity between June 5 and 27, 1924. The total height of the expanded inflorescence is recorded as 2·01 metres, the circumference of the spathe 1·30 metres. From temperature readings Mr. Dakkus concludes that but little heat is developed in the tissues during growth, though the data given seem to be obtained simply from readings of the air temperature within the unexpanded spathe. This giant inflorescence has frequently been seen at Kew, and the editor of the *Gardener's Chronicle* reports that a new and large tuber has recently reached Kew. The plant is a native of Sumatra.

THE POISONOUS ACTION OF COPPER AND MERCURY SALTS IN PLANTS.—In view of the growing practice of trying to sterilise seeds before germination, considerable interest attaches to the attempts of H. Lundegårdh to establish some general fundamental points as to the toxic action of the ions of copper and mercury upon the plant (*Biologisches Centralblatt*, 44, pp. 465–487, September 1924). These ions are absorbed very strongly in the fruit coat of wheat grains by a process which is apparently strongly periodic, like the Liesegang ring phenomenon, and the author thinks it is in this case based upon the interference between primary copper absorption and secondary alterations of the degree of swelling of the material of the fruit coat. Germination and germination energy are as a consequence differently affected by different concentration, so that, whilst a very low concentration may be harmful, a slightly higher may be beneficial if anything, whilst a higher concentration again inhibits or depresses germination. Obviously these results may have great bearing upon practice, and show that great caution will be necessary in establishing the concentration of such toxic substances when used in seed sterilisation.

EXPLORATIONS IN THE LIBYAN DESERT.—Mr. Hassenein Bey's account of his journey across the Libyan desert through Kufra to Darfur appears in the *Geographical Journal* for October and November. It is followed in the November number by a long article

by Dr. J. Ball discussing the cartographical results of the journey. Dr. Ball briefly summarises the additions to our knowledge of north-eastern Africa as follows: The true positions of Zieghen and Kufra have been shown to be 100 and 40 kilometres respectively from the hitherto assigned positions. Oases discovered at Arkenu and Owenat open up possibilities of new routes into the unexplored regions of the Libyan desert. A new route with water courses along it has been mapped across the Erdi and Ennedi plateau, and valuable information, including barometric levels, has been collected over a vast region, confirming Col. Tilho's conclusion that there is no possible drainage outlet from Lake Chad in an easterly direction. Two papers follow on the geological data by Dr. W. F. Hume and Mr. F. W. Moon.

Problems of Antarctic Sea-ice.—In "Manchester Memoirs," vol. lxviii., No. 7, Mr. R. W. James discusses some problems of pack-ice, especially in regard to the Weddell Sea. The most interesting part of the paper deals with the salinity of sea-ice. It is well known that pack-ice, particularly in old pressure hummocks, on melting yields water fresh enough to drink. Freshly formed ice yielded on melting a solution with 1·2 to 0·7 per cent. of sodium chloride. Older pack-ice which has been exposed to weathering for at least one summer has a salinity of 0·2 per cent. This old hummock ice has a vitreous appearance and has lost the original fibrous appearance that is characteristic of new ice. One condition of loss of salinity in old ice seems to be elevation consequent on pressure, which enables the included saline liquid to drain by the action of gravity. Mr. James made the interesting observation that even at very low temperatures (*e.g.* – 30° C.) certain of the salts contained in the ice are in solution and may be lost by draining. But he believes that for sea-ice to lose its salinity, exposure to high summer temperatures is also necessary. Tentatively he advances a theory to account for alternate rise and fall of temperature leading to drops of saline liquid descending through the ice without it being actually porous.

The Oilfields of Argentina.—The time was ripe for an up-to-date and authoritative summary of petroleum developments in the Argentine, and Mr. Campbell Hunter's paper, read at the Institution of Petroleum Technologists on November 4, attracted attention because of this, quite apart from the technical interest of the communication. It has been difficult both for science and the oil industry to gauge with any assurance the commercial possibilities of the Argentine as an oil producer, largely because only the broadest facts of essential geology are known, and also because the vicissitudes of past operations there have proved somewhat bewildering. Success in one part of the country has often been counteracted by failure in another, at all events from a commercial point of view. In spite of widely separated operations spread over a number of years, the chance find of petroleum in a water well at Comodoro Rivadavia in 1907, the impetus this gave to the industry, and the position of that field to-day as the most important in the country—the output averages some 750,000 tons annually—are still the outstanding features of oil exploration in this part of the world. At Comodoro Rivadavia the oil is apparently obtained from Cretaceous beds (Danian and Senonian), in which lenticularity is the dominant factor, though owing to a thick covering of Quaternary deposits and the presence of two unconformities within the Tertiary sequence, the geological structure of the oil-bearing rocks remains doubtful. The oil has a gravity of 0·912, a viscosity (at 15° C.) of 21·15, flash point 22° C., with 77 per cent. distilling over above 300° C. It is thus essentially a fuel oil, and is used as such at Buenos Aires and Bahia Blanca, where most of it is shipped. Other actual and potential oilfields include those of the Province of Neuquen, the Cerro Alquitran and Cacheuta fields of the Province of Mendoza, and the Salta-Jujuy territory bordering Bolivia. Two economically important veins of high grade asphalt occur near the ancient volcano Auca Mahuida; from the analytical details given, this bitumen is remarkably pure, and recalls some of the grahamite successfully mined in the United States. Future prospects of the Argentine as an oil-producing country lie in extending the Comodoro Rivadavia field, and in the more intensive development of fields such as those of Neuquen, where higher grade oils are obtainable and from which South American markets must eventually be fed.

Selenium Cells and X-rays of Various Wave-lengths.—Dr. H. Küstner describes experiments in which he has compared the action of X-rays on selenium cells, and on ionisation chambers of greatly differing dimensions, in the *Zeitschrift für Physik* of September 2. It is not possible to use fully monochromatic X-rays, as the selenium cell is not sufficiently sensitive; but copper filters of varying thickness were employed with different voltages on the X-ray tube, so that different degrees of hardness were obtained. The average wave-length varied from 0·119 Å to 0·473 Å. The larger of the two carbon ionisation chambers employed was 25·5 cm. high and 6·4 cm. in diameter, while the smaller "thimble" chamber was 21 mm. high and 14 mm. diameter. The ratio of the reading with the selenium cell, and that with the large chamber, showed a maximum at about 0·22 Å, and only half this maximum value was observed at about 0·12 Å and 0·4 Å. This behaviour cannot be related to an absorption spring in selenium, since the shortest wave-length of an absorption band head, that of the K series, is near 0·979 Å. The fact that the ratio between the values obtained with the two ionisation chambers varies with the hardness excludes a suggestion that the X-rays do not produce the full amount of ionisation, being absorbed by the walls of the chamber. An attempt is made to explain the phenomenon as being due to the difference between the scattering and pure absorption effects in air and in selenium. Although a quantitative treatment is not at present possible, a qualitative explanation is obtained.

Atomic Rays from Heated Salts.—In the *Annalen der Physik* for October, Dr. G. C. Schmidt describes experiments in which a platinum wire is coated with various salts, and heated electrically *in vacuo*. The wire is surrounded by a wire gauze cylinder which is connected to an electrometer, and the sides of the containing glass cylinder are lined with earthed wire gauze. Simple solid or fluid substances, which at a given temperature give out positive or negative ions, or both, conduct electrolytically at that temperature; if they give out electrons they conduct metallically. Salts in which the positive ions are alone mobile send out positive ions only, and similarly for negative ions; while, if the mobility of one kind of ion is greater than that of the other, the first is given out faster than the second at the temperature in question. Complexes such as Cd_nI_{2n} are formed in the solid salt, which disintegrate into $Cd_{n-1}I_{2n}$ and Cd^+. When iodine and bromine, which form complex salts, are present, they break up the large aggregates such as Cd_nI_{2n}, and so the number of ions increases and more are given off. At the same time a badly conducting layer forms on the wire and in the end the current falls. Measurements of the ratio e/m show that the salts of various metals send out positively charged metal atoms; the values of m thus

obtained are as follows—Cd 54-58·4, Cu 31·1-32·7, Zn 32·4, Pb 108·4, Ca 20·5; these are approximately half the atomic weights, since each atom carries the charge $2e$ of two electrons.

ELECTRICITY FOR AUXILIARY POWER ON SHIPS.—In a paper read to the Institution of Engineers and Shipbuilders in Scotland on November 18, by Mr. Gilbert Austin, a new system of electric driving which will be specially useful for driving the capstans, steering gear, pumps, fans, etc., used on board ship is described. The drawback to the ordinary shunt motor used on a constant voltage system is that it is practically a constant speed machine, and if it is pulled up there is a risk of the armature being burned out. The author has devised an ingenious system in which the current through the armature is independent of the speed, and the voltage of the constant current generator varies with the load. He shows how readily it can be applied to various kinds of ships. In a passenger liner, for example, there are three entirely independent circuits each actuated by its own constant current generator, which is driven by a steam turbine. At times of light load any one of the units may be used to supply the whole ship. Some startling statements were made about the cost of running steam auxiliaries. A 15-knot turbine vessel was found to be burning too much coal. It was found by tests that the main turbines took 75 tons of coal per day, whilst the various auxiliaries were responsible for 30 tons. The steam steering gear alone took 7 tons of coal per day. Assuming 250 days per annum at sea, and that coal costs 30*s.* per ton, the fuel cost alone for that particular steering gear amounts to 2625*l.* per annum. The author says that this steam steering gear could have been worked by a 40 horse-power electric motor at an annual cost of about 40*l.* Thus electric driving would effect a saving of 2585*l.* per annum for the steering gear alone. In another case, the loss of steam from 20 leaky joints in long lengths of steam piping was estimated to waste coal at the rate of 440*l.* per annum.

OLIVE OIL.—The *Chemical Trade Journal* for Oct. 24 prints a review of the olive-oil industry. Two varieties of olive tree are known, but only the cultivated thornless type, which exists in forty-five subvarieties, is used for oil-production; it is cultivated chiefly in Asia, Australia, South Africa, the Western States of America below latitude 35°, and, from the very earliest times, in Mediterranean countries. Spain and Italy are the two largest olive oil producing countries. The ripe fruit yields a sweet pale yellow oil if pressed immediately after gathering; stored ripe fruit gives an inferior colourless oil and unripe fruit a green, bitter oil. The extraction process is described in some detail; the physical and chemical properties are tabulated. The oil appears to consist of 70 per cent. tri-olein and 28 per cent. of tri-palmitin and tri-stearin, together with a small quantity of linolein and arachin. The applications of the oil and of the by-products of manufacture are discussed in detail, as also is adulteration. Its chief uses are for human consumption and in the manufacture of artificial leather and of soap.

THE ELECTRIC MOMENTS OF MOLECULES.—In the October number of the Journal of the American Chemical Society, C. P. Smyth shows how the electric moment of a molecule can be calculated from measurements of indices of refraction, dielectric constants, etc. These calculated moments are much smaller than those deduced from the hypothetical molecular structure based on G. N. Lewis's theory, and the conclusion is drawn that the charges shift under the forces of attraction and repulsion within the molecule, the discrepancy depending on the ease of displacement of the electrons. The electric moments of a series of alcohols, ethers, and analogous sulphur compounds vary from 1 to 2 times 10^{-18}; the value for water is $1{\cdot}98 \times 10^{-18}$, whereas the value deduced from the atomic structure model is $5{\cdot}51 \times 10^{-18}$. The forces required to displace an electron through unit distance are calculated in dynes $\times 10^{-6}$; water, 1·24; ammonia, 0·84; methane, 0·71; hydrogen sulphide, 0·51; and these are regarded as indicating the order of magnitude of the mobilities of the electrons in the molecules.

FLUORINE AND HYDROGEN FLUORIDE.—The preparation of fluorine by the electrolysis of fused acid potassium fluoride in a copper apparatus with a copper diaphragm and graphite anode is described by J. Simons in the October issue of the Journal of the American Chemical Society. Fluorine was obtained at the rate of 4 litres per hour, and the apparatus could be run for 20 to 30 hours. The same author also describes the preparation of anhydrous hydrofluoric acid, and measurements of its freezing-point ($-83°$ C.) and vapour pressure. Anhydrous potassium hydrogen fluoride was heated in a heavy copper retort; the vapour was passed through a tube packed with copper wire to remove salt spray, and condensed in a gold-plated copper cylinder. The relationship between pressure and temperature was found to be reproduced by the equation

$$\log P(\text{mm.}) = -1315/T + 7{\cdot}37.$$

Measurements of the vapour density of hydrofluoric acid, made by Simons and Hildebrand, are described in the same journal. Nitrogen was bubbled through the liquid acid, and the hydrofluoric acid vapour carried off was absorbed in weighed copper tubes containing sodium fluoride. From the known vapour density and the weight carried off, the density of the gas could be calculated. At the low temperatures used (15-19° C.) the molecular complexity exceeded H_4F_4. The results could be correlated with the vapour density measurements of Thorpe and Hambly at higher temperatures, by assuming that the vapour contains an equilibrium mixture of HF and H_6F_6 and a heat of association of 6670 cal. per mole of HF.

STAINLESS STEEL.—At an informal meeting of the Junior Institution of Engineers on November 21, Mr. J. G. Hopcraft discussed this material. The special properties of stainless steel are inherent and not merely superficial. The properties of withstanding heat and corrosion and remaining bright are produced immediately after tempering and removal of the scale, with polishing if necessary. The fact that the steel has to be heat-treated after being worked imposes a limitation on the size of job which can be undertaken, so that the production of large girders, for example, is not a commercial proposition at the present time. Stainless steel has good heat-resisting qualities and will not scale up to about 800° C., the effect on the surface being confined to colour effect only. The removal of scale from the inside of long tubes and similar inaccessible positions is difficult. Stainless steel cannot be expected to machine like mild steel, but with the right degree of hardness and a little experience in the use of the tools for the particular job, the turning and screwing, etc., of the metal can be carried out without much difficulty. A new stainless steel combining a high degree of resistance to corrosion with extreme malleability has recently been brought out under the name of "Stabrite." This metal can be produced in sheets for cold-pressed articles which require no further heat treatment. It cannot be hardened, but can be welded, soldered, and brazed fairly easily.

Science in South Africa.

THE twenty-second annual meeting of the South African Association for the Advancement of Science was held at Cape Town on July 7-12, under the presidency of Prof. J. A. Wilkinson, professor of chemistry in the University of the Witwatersrand, Johannesburg. The meeting was well attended, and more than 80 papers were read. Joint meetings of sections were held for a symposium on veld-burning and for the paper by Prof. H. B. Fantham on "Heredity in Man: its importance both biologically and educationally." There were various visits to places of scientific and historic interest in the neighbourhood, and a popular lecture was delivered by H.M. Astronomer at the Cape, Mr. H. Spencer Jones, on "Wireless Messages from the Stars." A scientific conversazione was arranged by the Royal Society of South Africa, and there was a reception by the Consul-General for Belgium.

The president of the Association, Prof. J. A. Wilkinson, gave as his presidential address, "A Review of some Developments in Chemistry during this Century." Commencing with a historical résumé, a synopsis was then given of progress in knowledge of the zero valency elements, radium developments, cathode rays, positive rays, atomic structure, X-ray spectra, newer work on isotopes, the configuration of the atom, X-ray crystal analysis, colloid chemistry and its developments, Werner's co-ordination theory, hydrogen-ion concentrations, and the theory of solutions. Progress in organic and inorganic analysis was noted, and the methods of soil analysis were outlined. The address concluded with a statement of the needs of research and an appeal for such research.

The presidential address to Section A was delivered by Dr. J. K. E. Halm, on "The Luminosities of the Stars." The history of progress in the several branches of astronomy was traced. The visual and photographic methods of obtaining photometrically correct magnitudes were discussed, and the practical applications of Planck's formula to the distribution of energy in stellar spectra were outlined. Methods of determining distances of stars were noted, and some new results recently obtained at the Cape Observatory in connexion with masses of the stars were outlined. The need of adequate equipment of observatories was urged.

Dr. A. L. du Toit, president of Section B, took as his subject, "The Contribution of South Africa to the Principles of Geology," in which he described the advances made, indicated the bearing of such discoveries in advancing geological theory, and suggested lines for future research. In mineralogy, reference was made to crocodilite and African "jade." The different origins of several kinds of asbestos in the Union, stanniferous ores in the Bushveld tin fields, gold-bearing conglomerates and kimberlite were discussed, and the Bushveld igneous complex of the Transvaal indicated as a field for research. The history of past glaciations in South Africa, and evidence of at least four past glaciations, were presented. The evidence for the existence of Gondwanaland and the hypothesis of continental disruption were discussed. The palæontological vertebrate assemblage of South Africa and its development were noted, as was the well-known Glossopteris flora. The address concluded with an appeal for more attention to field geology.

"Kirstenbosch, South African Botany and Nature Reserves," was the subject of the presidential address to Section C, given by Prof. R. H. Compton, who directed attention to the need for greater output of research, and for developing on national rather than on local lines. The creation of the National Botanic Gardens at Kirstenbosch, their history, manifold botanical possibilities due to situation, rainfall, variety of soil and many types of vegetation were described. Substations are projected, one of which, the Karroo garden, has materialised. The wide scope of the intended activities of the National Gardens was outlined and the need of pure research, in contrast to applied work, was emphasised. Kirstenbosch is also a sanctuary for the native flora and fauna of South Africa. The importance of the preservation of mountain catchment areas by an adequate covering of natural vegetation, the prevention of unnecessary veld-burning, the protection of the natural flora, and its preservation under natural conditions were urged.

Prof. E. H. Cluver dealt with "Some Applications of Physiology to Industrial Hygiene" in his presidential address to Section D. It was pointed out that all improvements directed towards improving health also increase efficiency. Developments in work on industrial fatigue, tests for the assessment of fatigue, arrangement of work periods, rhythmic movements, work postures, etc., were discussed. The importance of atmospheric conditions, such as heat and moisture, particularly in South Africa, in the mines and in factories, was emphasised. Dusty conditions, particularly silicosis, were considered. Dietetics were discussed from the point of view of under-development, correct feeding, and adequate supply of vitamins. It was pointed out that stunted growth and low resistance to pathogenic organisms are accompanied by industrial discontent, and physical inefficiency by inadequate output.

The presidential address to Section E, "The Education of the Native," was delivered by Mr. W. G. Bennie, who has had thirty years' experience of native education in the Cape Province. The historical landmarks in native education were first outlined, and the nature or scope of native education discussed. In primary schools a fairly liberal course with a strong industrial bias was recommended, the native language being the medium of instruction in early life and one of the official languages later. Instruction in physiology and hygiene and some form of handwork is essential. Secondary school work should resemble that for Europeans, suitable options being provided. Agricultural training is of great importance. A sympathetic attitude towards native education was urged, since the raising of the native is necessary for economic development, for the maintenance of our own civilisation, and from motives of justice.

The Chief Archivist of the Union, Mr. Graham Botha, delivered his presidential address to Section F on "The Public Archives—their Value to Scientific Research." After dealing with the widespread interest of the Archives, archive administration and availability, the Archives as a great storehouse of materials for research was dealt with at some length. The historian can find documents for reconstructing the history of the race and for studies in political and social evolution; the political economist can obtain materials relating to wages, land tenure, currency, commerce, development of resources; agricultural progress can be traced; sociologists can study to advantage the organisation and development of society in all its grades in South Africa. Documents on agrarian practices, plant life and forest reports are not only of intrinsic interest but also of economic importance. The Archives thus can provide abundance of material of great diversity for investigators in numerous fields of knowledge.

It is only possible to notice briefly some of the interesting papers read before the various sections.

In Section A, Dr. J. D. Schonken gave a paper on desiccation and how to measure it, defining desiccation, exsiccation, and siccation. He considers that a growing irregularity of rainfall provides a more trustworthy index of desiccation than the measurement of rainfall in inches. Dr. J. S. van der Lingen contributed a paper on the planetesimal hypothesis and dealt with uniform belts of planetesimals and equatorial accelerations. Dr. B. F. J. Schonland gave a paper on the scattering of the cathode rays, considering that the law of force in an encounter between an electron and an atomic nucleus appears to be that of the inverse square.

In Section B, Dr. B. de C. Marchand read a paper on the origin of black turf soils in the Transvaal. These are really clays, derivatives of plagioclase, and not particularly rich in organic matter. Mr. C. W. van der Merwe dealt with the formation of soil from diabase in the central Transvaal, the weathering being mainly due to chemical decomposition. Prof. G. H. Stanley reviewed metallurgical progress in the Transvaal during the decade 1914–1924. Mr. T. Leslie discussed the huge Transvaal formation of dolomite, which is very suitable for fluxes. Dr. J. J. Theron and Mr. J. V. Cutler gave a paper on the function of nicotine in tobacco, which their investigations show to be a storage product and not waste. Mr. Cutler also gave an account of the growth, ash content and constituents, and nicotine content of tobacco grown on experimental fertiliser plots at the Rustenburg Cotton and Tobacco Station. Mr. Steenkamp described the chemical composition of the latex of a Euphorbia. Dr. Theron wrote on the reaction of some Transvaal soils. Messrs. A. J. Pelling and J. B. Robertson further discussed the reciprocal salt-pair formed by sodium chloride and calcium nitrate. Studies on the thiazoles were contributed by Dr. J. L. B. Smith with Messrs. E. H. Flack and A. R. Inggs. Mr. O. G. Backeberg gave a paper on the theory of indicators. Mr. W. Torrance described his studies on metamorphic mudstones, and Dr. F. Nopcsa made a palæontological contribution on the systematic position of Saurosternon and Tangasaurus.

In Section C, Dr. R. Marloth gave a paper on the determination of acidity of soils. He considers Truog's test convenient and sufficiently accurate for the farmer. Prof. C. E. Bremekamp made a contribution on hydrotropism and thigmotropism of roots, and Prof. R. S. Adamson described some new cases of secondary growth in monocotyledons. The seaweeds of the Cape Peninsula and their distribution were discussed by Mrs. M. R. Levyns, the Atlantic and Indian Ocean seaweeds being contrasted. Notes on the aquatic flora of South Africa were presented by Miss E. Stephens. Mr. A. Stead contributed a paper on Saaidam terraces in the Karroo, a method valuable for securing an underground water-supply. Dr. J. S. van der Lingen gave three papers on plant pigments, including those of *Bacillus pyocyaneus*, which he has examined spectroscopically. Dr. W. F. Barker summarised his results on the function of the chloroplasts in carbon dioxide assimilation. Dr. T. Sim gave further notes on mosses from the south-west part of South Africa, and Prof. P. A. van der Bijl continued his descriptions of South African Polyporeæ. Mr. Pont contributed a paper on osmotic pressure in correlation with growth form and habitat. Mr. J. Phillips gave an interesting paper on the biology, ecology, and sylviculture of a valuable indigenous timber tree, *Ocotea bullata*, known as "stinkwood."

The symposium on veld-burning was opened by Dr. R. Marloth, who dealt in general with the problem, illustrating from occurrences in the South-west Cape, where thick evergreen scrub has been replaced by fire-resisting bulbs as a result of veld-burning, the run-off being greatly increased. Capture of water from the south-east cloud by mountain vegetation was urged. Mrs. M. R. Levyns spoke of the effect of veld fires on two contrasted areas in the Cape Peninsula. Mr. Pillans described the destruction of indigenous vegetation in the Cape and condemned veld-burning. Mr. Graham Botha contributed an historical account of the practice, originally derived from the Hottentots.

In Section D, Mr. A. D. Stammers dealt with the effect of altitude on health and longevity; from physiological experiments and statistical data he concludes that if certain minor precautions are observed, detrimental effects will not accrue from long residence at altitudes of 4000 to 6000 feet. Dr. Annie Porter gave an account of five kinds of insect larvæ observed by her in man in South Africa. Prof. R. W. M. Mettam described an ox liver possessing accessory lobes and so being more equine than bovine in character, and also described the greatly enlarged condition of the petrous temporal bone of a calf. Prof. H. B. Fantham gave an account of his further researches on parasitic Protozoa, and described *inter alia* a new Entamœba from a duck, a new Herpetomonas from the larva of Eristalis, and several new Trichodinas. Prof. Fantham also summarised the observations on various protozoal and helminthic parasites from South African Amphibia that have been investigated by Miss C. Weinbrenn and himself, and presented a further report, in collaboration with Miss N. F. Paterson, of their researches on the protozoal fauna of certain South African soils. The distribution of the soil Protozoa differs in the coastal belt, the Karroo belt, and the High Veld. It also varies in soils from False and Table Bays, which are adjacent. More work on seasonal variation in soil Protozoa and a preliminary account of the effect on them of veld-burning were also recorded. Mr. H. H. Curson presented a paper on the causal agents of nagana, showing that *Trypanosoma brucei*, *T. vivax*, and *T. congolense* are all associated with this condition in Zululand. Mr. H. H. Curson and Mr. J. M. Hugo discussed the preservation of game in South Africa, giving details of the various game reserves and measures for game preservation. Dr. C. S. Grobbelaar gave an account of his interpretation of the blood vascular system of *Xenopus lævis*. Dr. M. M. Prates sent a note on the fusiform bacillus-spirochæte association found among natives in Portuguese East Africa. Mr. J. Hewitt discussed the irreversibility of evolution, giving examples, particularly among spiders, tending to show that reversible evolution is possible by loss of mutations. Prof. J. E. Duerden and Miss M. Ritchie traced the development of the merino wool fibres from their first appearance to the birth of the lamb. Prof. Duerden and Miss G. Brock described the structure of the lining of the gizzard of the ostrich. A joint meeting was held with Sections E and F for a paper by Prof. H. B. Fantham on heredity in man, its importance both biologically and educationally. In this an account was given of various heritable traits, physical, mental, and moral, shown in man, both normal and abnormal characteristics being considered. The interaction of eugenics and euthenics was noted. Sociological applications were made, and suggestions put forward for educational betterment.

In Section E, Miss D. Earthy described various body markings employed more particularly by the VaChopi and VaLenge of Portuguese East Africa. Mr. A. J. H. Goodwin dealt with AmaPondo sibs. Col. W. E. Hardy exhibited stone implements col-

lected in the Cape and demonstrated methods of preparing them. Mr. G. D. Laing gave an account of Strandlooper skulls from Zitzikama, showing transition from a short face with light zygomatics to a long face with prominent zygomatics. Prof. R. A. Dart gave a paper on the Rooiberg cranium, which is probably not that of an ancient miner, but of a man who used the old mine as a dwelling. Prof. A. Radcliffe Brown gave details of the position of the mother's brother among the Bantu, a proper understanding of which is very necessary in dealing with native peoples. Prof. W. A. Norton and Mr. H. Velaphe presented sixty-eight Sesuto riddles with translations of the same. The science of tonetics and its application to Bantu languages was discussed by Dr. D. M. Beach.

In Section F, Advocate G. T. Morice discussed psycho-analysis and criminals, criticising various methods and certain new books. He considers Freudian psycho-analysis of little use, as it concentrates on the sexual and ignores other instincts. Prof. S. F. Gie gave an account of the economic development of South Africa from 1652 to 1795. Prof. R. D. Nauta gave a reasoned résumé of the moral value of Molière's works. The conception of intelligence was dealt with by Prof. R. W. Wilcocks. Much interest attached to a paper by Mr. C. S. Richards on the monetary history of South Africa since union, in which the currency problem and inflation of currency were dealt with, and a return to the gold standard advocated. Of much historic interest also was Miss M. L. Hodgson's paper on the Hottentot question in South Africa down to 1828. Prof. E. H. Brookes discussed the changes in native economic life in South Africa due to European influence and changes in Europeans due to native influences. He advocates economic differentiation and native development in agriculture and native industries, with no detachment of their natural leaders from the bulk of the Bantu. Mrs. Mabel Palmer gave an account of a South African Whitley Council as shown in the organisation of the printing industry. Rev. R. Balmforth pleaded for a more fully representative international authority than the present League of Nations.

As a result of Dr. Fantham's paper, the Eugenics and Genetics Committee of the Association has renewed its activities.

The next anual meeting of the Association will be held at Oudtshorn, under the presidency of General J. C. Smuts, in July 1925.

H. B. FANTHAM.

Sex Determination.

MANKIND has always been intrigued by the problem of what are the factors that determine sex, but it is only comparatively recently that a real light has been thrown upon this subject. The influence of the sex glands upon certain characteristics of the body has, it is true, been known for many centuries, as witnessed by the effects of castration, but the mechanism by which these changes are produced was obscure. With the discovery by Oliver and Schäfer in 1894 of the effects of suprarenal extracts upon blood pressure, a mechanism by which one part of the body may influence another (other than that involved in the intervention of the nervous system) was suggested, and experiments have shown that the action which the sex glands exert upon the body generally must be due to a substance or substances—"hormones" in fact, or chemical messengers—circulating in the blood stream. Thus removal of the testes or ovaries from their normal position to another part of the body produces no alteration of bodily appearance, although all nervous connexions must necessarily have been severed. Complete extirpation of both glands, however, leads to disappearance of those characters which are correlated with sex and are known as the secondary sex characteristics.

It is interesting to note that these characters vary considerably according to the species: thus the antlers in certain species of deer are present in the male sex only; the combs and spurs of cocks are peculiar to the male; in male frogs in the breeding season a clasping pad is developed on the thumbs. The external differences, however, between the sexes are especially well marked in birds, where the two sexes usually possess a very different plumage. For this reason, perhaps, those rare cases in which the creature during its lifetime changes its sex have been more frequently described in birds: these "freaks" have always excited much curiosity. In a recent paper in *Science Progress* (October 1924) F. W. Rogers Brambell describes some examples of this transformation. The change is always of a female into a male, and *post mortem* examination discloses the presence of testicular tissue as well as or without ovarian tissue: at times the latter is mostly degenerated. The change is therefore due to the development of a sex gland of the opposite sex; but the transformation is usually incomplete, some of the female characteristics remaining unchanged.

Now after simple removal of the sex glands from an animal the characteristics of the opposite sex do *not* usually develop; the change in appearance is towards a neutral type which, according to the species, may be either nearer to the male as in birds or to the female as in mammals. It is, however, certain that the actual appearance of the opposite sex depends on the development of the appropriate sex gland. Does this imply that every organism in species with separate sexes contains within itself the factors upon which the sexes ultimately depend? Probably this does not occur normally, the sex of the individual being determined at conception, possibly by the particular arrangement of the chromosomes in the ovum and spermatozoon which unite in fertilisation. The sex-determining chromosomes pass into the sex glands and thus influence the development of the somatic cells along the lines of the particular sex involved. In certain rare cases, however, of hermaphroditism or sex reversal the sex chromosomes of *both* sexes must be present, and the result is either a mixture of the two, or one predominates either completely or for a time.

This view is borne out also by the fact mentioned above that simple removal of the sex glands does not produce the characters of the opposite sex: on the other hand, the somatic cells are capable of being influenced by the secretions of *either* gland, and after removal of the normal glands, grafting of the glands of the opposite sex from an animal of the same species leads to the development of the characteristics of the grafted sex. The factors which produce any particular arrangement of the chromosomes in the ovum or spermatozoon and so lead to the appearance of the corresponding sex are not yet completely elucidated: it is, however, suggestive that in pigeons and doves, Riddle found a predominance of males amongst the offspring when the parents were the most vigorous, early in the breeding season. One factor which influences the constitution of the spermatozoon or ovum is therefore the general metabolic condition of the parent. Research along these lines may lead in the future to knowledge which will enable mankind so to arrange the conditions as to produce, with a fair amount of certainty, an offspring of the sex desired.

The Ramsay Memorial Laboratory, University College, London.

THE new Chemical Engineering Laboratory at University College, London, founded as a memorial to the late Sir William Ramsay, was opened on November 12 by H.R.H. Prince Arthur of Connaught, accompanied by Princess Arthur. There was a large gathering, including Lady Ramsay and representatives of university, professional, and industrial circles.

Sir Robert Robertson from the chair emphasised the need, felt especially during the War, for men trained in the development of chemical operations to the industrial scale. He laid stress on the necessity of thorough preliminary training in chemistry, physics, and mathematics, and also on the need for whole-hearted co-operation between the industries themselves and the new department, in providing facilities for students to extend their training to include actual works practice and the investigation of problems on a manufacturing scale. He stated that he noticed recently in America that it is possible for the universities to maintain a small colony of post-graduate students at the factories, working on fundamental plant problems, and that this arrangement seems to work to the utmost advantage of both students and manufacturers. He urged chemical manufacturers in Great Britain to consider the possibility of similar co-operation.

Prince Arthur of Connaught, in declaring the Laboratory open, sketched the history of the Ramsay Memorial Scheme, which has now been carried to completion. The new Laboratories—which are temporary—have been reconstructed and equipped under the guidance of Prof. E. C. Williams. In addition to the funds handed over by the Ramsay Memorial Trustees, the Laboratory has received generous support from many of the great British chemical firms, which, by subscriptions for a period of five years, have ensured a minimum income of 1400*l*. Further support is still needed to enable the Laboratory to rise to its full powers of usefulness to industry.

Mr. W. J. U. Woolcock, president of the Society of Chemical Industry, said that although there has, in the past, been some doubt as to the value of the chemical engineer, he looked forward to this pioneer laboratory, as a result of the course of studies which has been framed, sending out men who will play a great part in British chemical industry. He noticed with great satisfaction that Prof. Williams had laid stress on the planning of the large scale operations with special regard to the underlying chemical and physical phenomena involved, as well as on the actual design and operation of the plant. He foresaw the Laboratory becoming a centre to which chemical manufacturers would send their fundamental problems for solution, and although Great Britain is an old and conservative country, in which tradition dies hard, he appealed to manufacturers to bear in mind the possibility of still further co-operation along the lines indicated by Sir Robert Robertson.

Prof. E. C. Williams, in describing the scope and facilities of the Laboratory, said that the chemical industries require men of the same high scientific imagination and experimental skill as have done such great work in the pure sciences, but they must be trained to apply these gifts to the problems and plant operations of chemical industry. In the Ramsay Laboratory, men would be encouraged to develop processes from the test-tube scale to the industrial scale, and themselves to work out the whole of the data necessary for efficient operation on a commercial scale. Chemical engineering is essentially a quantitative science. Provision is made in the Laboratory for carrying forward investigations to the semi-industrial scale; a special laboratory has been built for this purpose, in which students can erect any plant they desire to their own designs and to meet their own special requirements.

A vote of thanks to His Royal Highness was moved by Sir John Rose Bradford and seconded by Mr. Roscoe Brunner.

After the ceremony, the Laboratory was thrown open for inspection. In addition to chemical and physical laboratories, there are provided a drawing office, mechanics shop, which is available for the use of students, and an industrial laboratory. The guiding principle in the design of the Laboratory has been flexibility. This is particularly apparent in the industrial or semi-large scale laboratory, where structures, services (including steam, gas, water, power, electricity, vacuum, and compressed air), and equipment are designed to give the greatest facility in the erection and operation of any desired experimental plant. The Laboratory is already well equipped with plant planned for quantitative investigation rather than for the illustration of industrial practice, it being felt that the latter can only be satisfactorily obtained at an actual factory.

Innermost Asia: its Geography as a Factor in History.

SIR AUREL STEIN delivered the first "Asia Lecture" before the Royal Geographical Society on November 3. He chose for his subject an account of his three expeditions to the Tarim Basin in Chinese Turkestan, which he undertook in the years 1900–1, 1906–8, and 1913–15. Sir Aurel has long held a foremost position as an archæologist and explorer. We well remember, many years ago, his interesting investigations into the identity of the site of Mount Aornus, described by the Greek historians, somewhere to the north of Attock, which Alexander the Great besieged on his way to India. Since then he has gone much farther afield, and his chief work has been in Central Asia.

The scene of these explorations lies in the great drainageless basins situated between the Tien-Shan, or "Celestial Mountains," on the north, and the Kun-lun ranges to the south which separate them from Tibet. To the west it abuts on the great mountain masses of the Pamirs, and on the east is bounded by the Nan-Shan forming the watershed towards the Pacific Ocean. This vast area is some 1500 miles long from east to west, and up to 600 miles wide from north to south. But "ground capable of settled life is strictly limited to strings of oases and only a few of them in the extreme east and west offer enough arable soil to support a population of some size. The rest of the area is occupied by huge stretches of desert . . . almost everywhere devoid of water."

This desert differs from the deserts of Arabia and South Africa, where whole tribes move about, sure to find grazing for their flocks, at least at certain seasons of the year. Such is not the case in the deserts of the Tarim Basin, where "the absence of moisture bans not only human existence, but practically also all animal and plant life," and what life there is, round the scattered oases, is entirely de-

pendent on irrigation derived from the water of glacier-fed rivers, which, if not artificially caught, rapidly disappears in the sand. This absence of atmospheric moisture is due to the immense distance which separates this region from the sea, and the high mountains which intervene on all sides.

The importance of the Tarim Basin lies in the fact that it was in the direct line of communication which once formed the great trade route between China and the West. Two thousand years ago it seems to have been the only means of interchange of commerce between the Far East and the West. Not only does the shortest route lie along it, but also the way to the north was barred by the presence of the fierce and warlike Huns and the Tien Shan Range, while to the south the snow-clad mountains of Tibet and the Himalayas formed an impenetrable barrier. Formidable as the passage of such a desert must have been, it appears to have presented less difficulties to the Chinese than were likely to be encountered on any alternative route. These circumstances accounted for the control China found it necessary to assume over this far-extended line, which eventually reached to the Pamirs. This was at first of a political nature, but ended in complete military occupation lasting for a thousand years. Sir Aurel Stein has been able to trace over a long distance the remains of the old *Limes*, or defensive wall, erected at the end of the second century B.C., no doubt the ancient representative of our modern line of block-houses.

The reasons for the abandonment of such a route as this, and the evacuation of the former inhabitants, give rise to interesting speculation. Was it due to an alteration of climate bringing about excessive desiccation, or to some other cause? From the high state of preservation of records, and other materials, discovered by Sir Aurel, it would appear that the climate has not altered and is much the same now as it was 2000 years ago, for such friable objects as were found could only stand the test of time in an extremely arid climate. If, then, the occupation of this area was independent of climate, it must have been dependent on irrigation, which in its turn was dependent on water derived from glacier-fed rivers.

The lecturer discovered several abandoned sites of human habitation which had been maintained by irrigation, but are now far distant from the terminal point of the river which formerly supplied them with water. This seems to show, as originally suggested by Sir Sidney Burrard, that the evacuation of this area was due to the diminution of water in the rivers and not to an alteration of climate, of which there is no evidence. The glaciers, probably the remains of a former ice-age, are known to be shrinking, with the consequent decrease of the water supply, which probably accounted for the abandonment of this important commercial highway. But while this seems to afford an explanation, it is not safe to rely entirely on it, as there is always the human element to be taken into account, and that is not so easy to gauge. The way in which the Chinese have held this region, throughout the long years of varied history, is a remarkable testimony to their tenacity of purpose. On more than one occasion it has been lost, generally on account of internal dissensions, only to be regained in more settled times, and is held down to the present day.

It is to be hoped that at some future time Sir Aurel Stein will give us some details of the contents of the documents he has found, and of other objects of interest. We may add that he was accompanied on his expeditions by surveyors of the Indian Survey, and that a series of maps on a scale of 1/500,000, and 1 inch to 4 miles, have been produced by that department as the result of his surveys. H. L. C.

Tropical Medicine in the Southern United States.

THE recent Conference on Tropical Problems at Kingston, Jamaica, has served to direct attention to the enormous interest which is taken at the present time in tropical medicine and allied sciences in the United States. This movement may be said to have started some thirty years ago when the States had to take control of the Philippine and Cuba Islands after the Spanish War; it became greater when it was decided to open the Panama Canal. The building of the canal was rendered possible by the genius of Gorgas, who applied in a practical way the discoveries of Ross and Manson. The scourges of yellow fever and malaria which had caused the complete failure of the French effort were successfully combated, and the canal was built.

A very important feature of the moment is that private concerns and corporations with estates and financial interests in the tropical zone are taking great interest in tropical medical problems. Some of these concerns have complete medical services of their own. The United States Fruit Company, for example, has a tropical medical service admirably organised, with branches in several Central American countries, Guatemala, Costa Rica, Honduras, etc. At the head of each branch or division there is a principal medical officer with an adequate medical and nursing staff in each division. The Company has built one of several up-to-date hospitals with splendid laboratories, X-ray departments, etc. Some of these hospitals are magnificent, and would adorn any big European or American city.

Several United States universities, as, for example, Harvard, established departments of tropical medicine some years ago. Funds have been collected now to found a large and up-to-date tropical school at New Orleans, and to institute a professorship of tropical medicine at the University of that city.

New Orleans certainly seems to be from every point of view the ideal place for such a school; it is in one of the most southern parts of the States (Louisiana), and tropical diseases are far from scarce there; yellow fever used to be a scourge in Louisiana and other southern United States, and malaria is still common. It has intimate trade relations with Cuba, Mexico, and Central and Southern America. It has the most famous university (Tulane) in the south, and modern progressive scientific institutes.

The authorities of Tulane University have offered the university professorship and the directorship of the new school to Dr. Aldo Castellani, lecturer at the London School of Tropical Medicine and Director of Tropical Medicine at the Ross Institute. Dr. Castellani is known by his discoveries in connexion with sleeping sickness, yaws, and several other tropical diseases. It may also be remembered that it was Dr. Castellani who, some years before the War, devised and prepared the combined typhoid + paratyphoid, and the typhoid + paratyphoid + cholera vaccines which, after much discussion, were generally adopted by all the allied armies, instead of the simple typhoid vaccination. He has written jointly with Dr. Albert J. Chalmers a standard text-book on tropical medicine, which has run already into three editions.

The Cinematograph in Anthropology.

AT the Royal Anthropological Institute, on November 18, Capt. M. W. Hilton-Simpson showed a cinematograph film of native life in the Algerian Hills. Last winter, when they commenced their sixth season of ethnological research among the Shawiya tribes of the Aures Hills in S.E. Algeria, Capt. and Mrs. M. W. Hilton-Simpson were accompanied by Mr. J. A. Haessler, who is beginning to compile a "library" of cinema films destined to illustrate the ethnography of primitive peoples. He secured a series of pictures among the Shawiya, from which Capt. Hilton-Simpson and he have prepared a film which shows how arts, crafts, and customs, when once they have penetrated to the remote valleys of the Libyan hills, have persisted there unchanged until this day.

The film begins by illustrating the inaccessibility of the inner valleys of the Aures Massif. It shows cave dwellings, palæolithic in their simplicity, still inhabited by the Shawiya (Berber) tribes; and it traces the growth of the cave dwelling to the stone-built Shawiya hut. Views of hamlets of the Aures demonstrate how the villages can have altered scarcely at all since the time of Jugurtha as described by Sallust. The film also shows the occupations of the modern male population; their primitive basketry; the fashioning of wooden door-locks (probably of Roman origin); the chipping out of quern stones; and their methods of husbandry. This last included a complete series of pictures illustrating the use of a "water clock" in connexion with irrigation.

Owing to Mrs. Hilton-Simpson's long acquaintance with the Shawiya women, a full series of photos of the activities of these Mohammedan women has been obtained. The two most complete series of pictures are those representing their weaving and the making of pottery. The former, which appears to date back to early Egyptian times, is shown in all its processes from the shearing of the beast to the finished fabric. The pottery-making, which is done by hand, without the aid of a wheel, appears to be more ancient in its origin even than the weaving.

The final reel of film deals briefly with folk-lore, and illustrates some customs which, it seems certain, constitute a survival of the cult of the great goddess of fertility and the crops, who was worshipped in Libya in early times. The conclusion to be drawn from the film is that, contrary to the belief of the natives themselves and of many European visitors to Algeria, the Shawiya owe but little to the influence of the Roman occupation of the country round; but still keep alive arts, crafts, and customs with which they were probably acquainted long before the fall of Phœnician power in Africa.

University and Educational Intelligence.

CAMBRIDGE.—The Adam Smith Prize has been awarded to G. T. Griffith, Trinity College, for an essay entitled "A discussion of the causes contributing to the increase of the population in England and Wales during the Industrial Revolution, with some inferences drawn from Ireland."

LEEDS.—On grounds of intellectual distinction and of long and meritorious service to the University, the Council has decided to confer the title of emeritus professor upon Dr. J. B. Cohen, who recently retired from the chair of organic chemistry.

Mr. J. W. Baker, senior chemistry master at Barnard Castle Secondary School, has been appointed to a new demonstratorship in organic chemistry.

LONDON.—Dr. F. L. Hopwood has been appointed, as from October 1, 1924, to the University chair of physics tenable at St. Bartholomew's Hospital Medical College. Dr. Hopwood has had considerable experience as a lecturer in physics. During the War he was for three years a research physicist to the Admiralty, and received an award of 1000*l.* for his inventions used by the Service. He is the author of a number of papers in the *Phil. Mag.* (1915–16) and Proc. Phys. Soc. (1921–23).

The title of professor of botany in the University has been conferred on Dr. F. E. Fritsch in respect of the post held by him at East London College. Since 1907 Prof. Fritsch has been head of the Department of Botany at East London College; he has published a number of papers on freshwater Algæ. The title of reader in human embryology in the University has been conferred on Dr. R. J. Gladstone, lecturer and senior demonstrator in anatomy at King's College. The title of emeritus professor of mathematics in the University has been conferred on Dr. M. J. M. Hill, who held the chair of pure mathematics at University College from 1884 to 1923.

Miss Mary Brodrick, a former student of University College, has made a donation for the foundation of an annual prize in geography at that College.

Two University Travelling Scholarships (open to internal and external graduates in all faculties), each of the value of 275*l.* per annum, and three University Post-graduate Studentships (open to internal and external graduates in the faculties of theology, arts, laws, music, and engineering), of the value of 150*l.* per annum, are to be instituted.

The following doctorates have been conferred: D.Sc. (*Zoology*): Mr. H. G. Cannon (Imperial College—Royal College of Science), for a thesis entitled "On the Development of an Estherid Crustacean"; D.Sc. (*Chemistry*): Mr. L. E. Hinkel (King's College), for a thesis on "Reactions in the Hydroaromatic Series resulting in the Formation of Aromatic Compounds."

Dr. G. V. Anrep has been awarded the William Julius Mickle Fellowship for 1925, of the value of 200*l.*, in respect of the work which he has carried out during the past five years in experimental physiology.

Fifteen entrance scholarships and exhibitions are available for award to students entering University College in October 1925. Three of them are tenable in any of the five College faculties: arts, laws, science, engineering, medical sciences, or in the School of Architecture. One is tenable in each of the faculties of science, engineering, three in the faculty of medical sciences, two in the School of Architecture, and one in the School of Librarianship.

A course of five public lectures on "Modern Bacteriological Technique" is to be begun at the Royal College of Surgeons of England on December 11, at 4 o'clock, by Mr. F. W. Twort, Superintendent of the Brown Institution. The succeeding lectures will be given on December 12, 15, 16, and 17. No tickets will be required.

OXFORD.—The Edward Chapman Research Prize, value 20*l.*, will be offered for competition at the commencement of summer term, 1925, to members of Magdalen College who shall have been in residence for a period of two years, for a published piece of original research in natural science. Competing papers or memoirs must reach Mr. R. T. Gunther, Magdalen College, by, at latest, May 1.

THE Scholarship of the Institution of Petroleum Technologists, granted to a student member of the Institution who is completing the petroleum

technology course at the University of Birmingham, has been awarded to Mr. Geoffrey Cotton.

IT is recorded by the *Times* correspondent at Brussels that the foundation-stone of the new buildings of the University of Brussels was laid on November 20 by Prince Leopold. The erection of the new premises has been made possible by financial assistance, amounting to nearly 20,000,000 francs (about 208,300*l.*), given by the Commission for Relief in Belgium and the Educational Foundation, as a result of the good offices of Mr. Hoover. The ceremony coincided with the fiftieth anniversary of the Polytechnic School, and was attended by a number of delegates from British and American universities and technical institutions.

THE Board of Education has issued the following list of successful candidates (in order of merit in each group) to whom awards have been made in the competition for Royal Scholarships and Free Studentships (Science), 1924. GROUP A. ENGINEERING. Number of competitors, 102. *Royal Scholarships*, W. G. Crocker, A. A. Butler, A. W. Morley, J. Donegan, E. W. Packenham, R. A. Yeo, G. W. Mills, W. J. Offord; *Free Studentships*, R. S. Bone, A. S. Crouch. GROUP B. PHYSICS. Number of competitors, 42. *Royal Scholarships*, F. Gill, E. T. D. Offer, D. T. Jones, W. H. Aldous, A. H. Nagle; *Free Studentships*, L. F. Stanley, W. D. Wright, W. Singleton. GROUP C. CHEMISTRY. Number of competitors, 29. *Royal Scholarships*, J. Cantor, A. O. Ball, J. D. Johnson, F. Witt, M. Kamenetsky, P. L. Jones; *Free Studentships*, E. Tanner, J. Anderson, T. Mitchell. GROUP D. BIOLOGY. One candidate. No award. GROUP E. GEOLOGY. Number of competitors, 4. *Royal Scholarship*, F. E. Eames.

THE Rensselaer Polytechnic Institute of Troy, in the state of New York, celebrated last month the hundredth anniversary of its foundation, and Prof. Ray Palmer Baker has contributed to *The Scientific Monthly* an account of some of its services to the cause of science. The first head of this "the oldest institution devoted to science in any English-speaking country" was Amos Eaton, an original genius whose eminence as a naturalist—he has been called the "father of American geology"—was surpassed by his even greater renown as an educator. "He ranged over many subjects—botany, zoology, physics, chemistry, geology, and mineralogy; and in every field he fired the imagination of students who outreached him in knowledge and attainment." He was the first to introduce field work and laboratory practice into the American college, and was the founder of the first popular museum of natural history. His were the first attempts to adapt the results of research to the needs of agriculture. Among other distinguished Rensselaer men were: Ebenezer Emmons, from whose monographs originated the bulletins of the Department of Agriculture; Asa Fitch, the first official entomologist in America, known as the "father of economic entomology"; De Volson Wood, who inaugurated the system of independent colleges for the pure and applied sciences; Henry Augustus Rowland, first professor of physics in Johns Hopkins University, than whom there is no more significant figure in the history of physics in the United States; James Curtis Booth, the most distinguished chemist of his day, who organised at Philadelphia a laboratory on the lines of a miniature factory, the first of its kind; and James Hall, "the founder of American stratigraphy and invertebrate palæontology."

Early Science at the Royal Society.

November 30, 1663. This being the anniversary election-day of a new Council for the year ensuing, the Society met in a solemn manner. The Society proceeded, according to their charter, to the election of the Council and Officers for the year ensuing, observing the orders prescribed for that purpose in their statutes, there being present fifty-seven or fifty-eight fellows.

December 2, 1663. Mr. Boyle moved, that Mr. Povey, Mr. Hoskyns, and others, who could, might bring in their collections of observations concerning springs.

1669. Mr. Hooke produced a picture printed after the expeditious manner of Dr. Wren, who having covered a very thin brass-plate with etching varnish, caused it to be etched upon by a hand careful not to close any letter, in which work the aqua fortis must be so strong, as to corrode the plate quite through: which done, the plate is to be turned and laid upon another thick plate covered all over with printer's ink, to be passed, after the usual manner, through the rolling press.

December 3, 1662. Dr. Power's paper of subterraneous experiments, and observations made of the damps of coal-mines, was read, and registered.

1674. It was resolved, that every member of the present council shall provide an experimental discourse for the Society to be made at some one public meeting within the year, either by himself or some other member of the Society; or to pay forty shillings.

December 4, 1666. Sir Robert Moray proposed, that the council would take into consideration, how the experiments at the public meeting of the society might be best carried on; whether by a continued series of experiments, taking in collateral ones, as they were offered, or by going on in that promiscuous way, which had hitherto obtained.—The earl of Northampton and the lord bishop of Exeter were desired to speak to the duke of Buckingham, that he would accommodate the society with some rooms in York-house for their meetings.

1672. Mr. Oldenburg produced and read a letter from Mr. Lister concerning veins and other curious observables in plants, and particularly of the liableness of all vegetable juices to be frozen, except the milky one. It was ordered to be entered in the Letter-book.

1673. There was present at this meeting the abbé D'Angeau, brother to the marquis of that name, who had attended her royal highness the duchess of York from Paris to London.

December 5, 1667. Mr. Oldenburg produced a great packet of letters and other papers sent to him by Mr. Hevelius. To which were added several relations of other particulars communicated by some learned men at Dantzick, of their own accord, concerning trials made of injecting liquors into human veins, an odd birth of twins, and a suggestion of new materials for telescopical glasses, etc. Of these only that on the trials of injection was read at this meeting. [Oldenburg records that upon hearing the account, a certain physician then present, to Oldenburg's "great grief," was so precipitate as to denounce it. I could not (he says) but take him afterwards aside, and represent to him how he would resent it, if he should communicate upon his own knowledge an unusual experiment to the curious at Dantzick, and they in public brand it with the mark of falsehood: that such expressions in so public a place and in so mixed an assembly would certainly prove very destructive to all philosophical commerce, if the curious abroad should be once informed, how their symbolas were received at the Royal Society.]

Societies and Academies.

LONDON.

Royal Society, November 20.—J. **Barcroft**, M. L. **Anson**, A. E. **Mirsky**, and S. **Oinuma**: The correlation between the spectra of various hæmoglobins and their relative affinities for oxygen and carbon monoxide. Hartridge's reversion spectroscope was used, and it was found that if A be the position of maximum intensity of the α-oxy-hæmoglobin spectral band and B that of CO-hæmoglobin in mammalian blood, and K the equilibrium constant of the equation $CO + HbO_2 \rightleftarrows COHb + O_2$,

$$\text{Log } K = 0{\cdot}05\ (A—B),$$

A and B being in angstrom units. The relation is also true of the recrystallised hæmoglobins. Log K is a measure of the change in free energy involved in the reaction. The value of (A—B), called in the paper "the span," varies from 43 to 56 angstrom units in the mammals observed. The variation in individuals in the same species is very marked, and seems to be due to specificity of the globin portion of the molecule. Brown and Hill's observations on effect of temperature on blood have been treated along similar lines.—H. R. **Hewer**: On certain abnormalities occurring in the pituitary of the frog. Three types of abnormalities are described in the pituitary of the frog: (*a*) Proliferation of cells in the *pars nervosa*; (*b*) formation of non-ciliated cysts in the hypophysial region; (*c*) formation of ciliated cysts in the same region as in (*b*). Probably the non-ciliated and ciliated cysts are similar if not identical in origin. The cilia are therefore incidental, and possibly derived from the epithelium enveloping the anterior lobe.—A. **Howard**: The effect of grass on trees.—J. W. **Pickering** and F. E. **Taylor**: Blood coagulation, anti-coagulants, and hæmolysis. Most substances which inhibit the clotting of blood also inhibit hæmolysis. The anti-coagulants employed were potassium oxalate, sodium citrate, "peptone," leech extract, neutralised thymus, and yeast nucleic acids, novarsenobillon, cobra venom, egg-white, and sugars. A general correspondence between anti-coagulants and substances antilytic to platelets does not exist. The phenomena in protection against hæmolysis and clotting are parallel up to the stage of thrombin formation in the latter process, and experimental evidence shows that the inception of the clotting of blood, like hæmolysis, is essentially the lysis of a colloidal complex, and that both these phenomena are inhibited in a similar manner by certain protective substances. These results support the view that the inauguration of the clotting of blood arises from the disassociation of a protective colloid with the clotting complex of the plasma.—R. J. **Ludford**: The distribution of the cytoplasmic organs in transplantable tumour cells: with special reference to dictyokinesis.—E. **Ponder**: On the balloon-like structure of the mammalian erythrocyte. In the case of the human erythrocyte, the experimentally obtained figures agree in a striking manner with the figures deduced by considering the cell as a balloon-like body with a membrane for which Poisson's ratio is about the same as for most known substances. From this result it may be deduced that Rollett's view of the structure of the erythrocyte is at variance with the facts, and therefore untenable.—V. B. **Wigglesworth**: Uric acid in the Pieridæ: a quantitative study. The wings of the male contain 0·5 mg. and of the female 0·3 mg. of uric acid. This sexual difference is due to the greater size of the wing scales. The pupa of *Pieris brassicæ* contains about 2 mg. of uric acid. This total amount is not changed during development. In the resting pupa most, if not all, of the uric acid is contained in the fat body. Shortly before emergence, some is deposited in the wings and more is transferred to the gut. There is no evidence for a new formation of uric acid during pupal life. The Pieridæ appear to differ from other families in the use to which uric acid is put, and not in the amount of this substance produced.—G. Lindsay **Johnson**: Contributions to the comparative anatomy of the reptilian and the amphibian eye, chiefly based on ophthalmological examination.

Linnean Society, November 6.—E. B. **Poulton**: Mimicry among Fijian butterflies. Of the four species of Euplœa, three had, in the western islands, gained pronounced white marginal patterns in mimicry of the fourth (*helcita*), this last being probably kept constant by fresh invasions from the islands farther west. The ancestral forms of the three species, with reduced patterns, still persisted in east Fiji, and occasional intermediates were found in Taveuni, near to the eastern group, and in the isolated Kandavu. *Helcita*, the model of the other three species in the west, became itself a mimic with reduced pattern in the east, although some reciprocal approach appeared to have taken place in the others, especially the females. *Hypolimnas bolina*, an abundant Nymphaline butterfly with a constant male, had produced, among a wonderful series of female forms, one which was a mimic of the dark eastern Euplœas, and another mimicking the more strongly patterned species of the west. In some islands, especially Viti Levu, many all-female families had been bred; males occur in the island, although far more rarely than females. There was no reason for supposing that these female families were produced parthenogenetically.—Mrs. W. H. **Pearsall** and W. H. **Pearsall**: Phytoplankton of the English lakes. These lakes fall into three groups according to their plankton types: (1) those with green Algæ dominant; (2) those with Dinobryon dominant; (3) those with diatoms and Myxophyceæ dominant. This classification agrees very exactly with their classification according to physical characters, water analyses, and rooted vegetation.—B. M. **Griffiths**: Studies in the phytoplankton of the Lowland Waters of Great Britain: the phytoplankton of Shropshire, Cheshire, and Staffordshire. The natural waters of Shropshire and Cheshire frequently show "water-bloom," due to a prodigious development of blue-green algæ. The algal flora of the district is poor in desmids. One new desmid, a remarkable twisted form, was found in Marbury Mere, and named *Closterium tortum*. In general, these Lowland waters resemble those of the European plain, and differ from the lakes of the British mountain areas.

Aristotelian Society, November 10.—Judge **Dowdall**: What is a society? A society is an interrelation of human action which is complementary, or a number of men regarded as standing to one another in that relation. It is based upon a community, community being defined as an abiding system of mental dispositions such that each member of the society is disposed to perform his appropriate part of the interrelated action as occasion requires. The occasion and the action which it requires are determined partly by institution, an institution being defined as a mental structure determining persons to certain types of conduct in certain types of contingency.

Royal Meteorological Society, November 19.—Sir Gilbert **Walker**: Note on Bjerknes's contribution of 1921 to the mechanics of the general circulation. The object of the note is to elucidate several important

theorems due to Bjerknes; these deal with the slope of surfaces of discontinuity between portions of the atmosphere under various conditions; and so throw light on the general circulation.—W. H. **Dines**: The correlation between pressure and temperature in the upper air, with a suggested explanation. It has been considered that this correlation is due to the fixed relationship between the pressure at the surface, the pressure at any height, and the temperature of the intervening air column. This relationship partly accounts for the high correlation in the troposphere, but fails entirely to account for that in the stratosphere; similarly with regard to the equation for adiabatic change of temperature with change of pressure. If air is forced outwards from the cyclone towards the anticyclone in the upper half of the troposphere, the observed changes of temperature indicated by the correlation coefficient will be produced. This explanation is also valid for the fall of the tropopause in cyclonic regions.

CAMBRIDGE.

Philosophical Society, October 27.—J. T. **Saunders**: The hydrogen ion concentration of the waters of Lake Lucerne. Observations of the P_H of Lake Lucerne during July and August 1923 showed that considerable variation occurred at different depths. The P_H of the surface (0 metres) increased from 8·4 at the beginning of July to 8·7 at the beginning of September, and a similar relative increase was found in all layers down to the bottom. The P_H of the water below 30 metres is about 0·45 less than that of the surface, and from this depth to the bottom (100-200 metres) it is the same, except that just over the bottom a slight decrease (0·02-0·05) was observed. The maximum during calm conditions is found in the layer at 5-6 metres, and this is due to the photosynthetic activity of the phytoplankton.—J. **Gray**: The process of cell division in the eggs of echinoderms. The form of the cleaving egg is due to the growth of the asters and the force exerted by the surface layer of the cell. —V. **Nath**: Oogenesis of Lithobius. The formation of vitelline yolk in the oocytes is preceded by nucleolar extrusions, and the two processes are associated with each other. The fatty yolk is formed from the Golgi rods. Mitachondria are also present.—H. Singh **Pruthi**: Studies on insect metamorphosis—1. Prothetely in mealworms (*Tenebrio molitor*) and other insects. Effects of different temperatures.—H. Munro **Fox**: Chlorocruorin.—C. G. F. **James**: Characteristics of complexes of conics in space of four dimensions.—T. M. **Cherry**: On integrals developable about a singular point of a Hamiltonian system of differential equations.—R. A. R. **Tricker**: A helical method of focussing β-rays.—D. R. **Hartree**: Some methods of estimating the successive ionisation potentials of any element.—Sir Joseph **Larmor**: Why wireless electric waves can bend round the earth (*v.* NATURE, November 1, p. 650).

MANCHESTER.

Literary and Philosophical Society, November 18.—G. **Andrew**: Note on the occurrence of Pachytheca in the Buildwas Beds. A single specimen of Pachytheca extracted from the Buildwas Beds is, so far as is known, the first specimen from this horizon. The specimen is a black carbonised sphere, diameter about 3 mm., and the surface originally was unbroken, but with a few irregular cracks. Subsequently the outer layer became fractured, displaying the characteristic structure of the organism: a central region, or medulla, surrounded by a cortex about 0·3 mm. thick. The cortex is composed of radiating tubes of about 8 μ diameter. Since the algal filaments are not shown, and since the specimen is single, it is referred to as Pachytheca sp. The Buildwas specimen, associated as it is with a shelly fauna which has not yet been studied in detail from the zonal point of view, cannot be dated accurately. The associated fossils indicate a wholly and definitely marine sediment.—C. L. **Barnes**: The Ben Nevis Observatory. The proposal to erect an observatory on Ben Nevis was first made in 1877 by Mr. Milne Holme, president of the Scottish Meteorological Society, and plans were drawn up, but no progress was made until 1881. In June of that year the late Mr. Clement Wragge began a series of daily ascents, which were continued by himself or an assistant until October. An observatory was opened in 1883, and put in charge of two salaried observers, whose duties were to read all the instruments, with certain exceptions, every hour of the day and night, and to make notes of phenomena such as fogs, haloes, rainbows, coronas, etc. A companion observatory was established at Fort William in 1890, as it was thought that simultaneous observations at the two stations would yield valuable results. In 1896 a smaller station was added, half-way up the mountain. The cost of maintaining the three was about 1000*l.* a year, towards which the Meteorological Office contributed 350*l.*, the remainder being subscribed by various societies and by private individuals. Eventually it was decided that the results were not commensurate with the cost, and on October 1, 1904, the observatory was closed down after twenty-one years of continuous work. The records and the log are accessible in the Transactions of the Royal Society of Edinburgh, vols. 36 and 42-44.

PARIS.

Academy of Sciences, November 3.—M. Guillaume Bigourdan in the chair.—L. **Lecornu**: The deformation of a spherical envelope.—E. L. **Bouvier**: The nidification and the metamorphoses of some saturnian hemileucids.—S. **Winogradsky**: The study of anaerobiosis in arable soil. An account of results of experiments with natural soil to which one per cent. of mannite or glucose was added. As test organisms, Azobacter was chosen as typically aerobic and Amylobacter as anaerobic. The moisture content was allowed to vary, loss of moisture giving increased access of air, and the proportions of the test organisms at various levels determined.—Maurice **Lugeon** and Nicolas **Oulianoff**: The geology of the neighbourhood of Camarasa (Catalonia).—Arnaud **Denjoy**: Series of rational fractions.—A. **Jygmund**: A generalisation of the method of Cesàro.—R. de **Montessus de Ballore**: The evaluation of $\log \underline{n}$.—Alexandre **Kovanko**: Series of functions with one complex variable.—E. **Merlin**: A geometrical property of curved surfaces.—Bertrand **Gambier**: The polygons of Poncelet generalised.—D. **Riabouchinsky**: Some general properties of plane movements of a liquid.—F. **Baldet** and E. M. **Antoniadi**: Observations of cloud-capped protuberances which recently appeared on Mars. The positions and movements of these protuberances, observed between October 10 and 13, are shown in seven drawings.—A. **Brun**: The discovery of a new variable star, with a period probably very short. This star, +80°·5030 in the Greenwich catalogue, varies in magnitude between 12·6 and 13·3 in a period of less than two hours.—T. **Peczalski** and A. **Launert**: The velocity of cementation of copper as a function of the temperature.—Mlles. Marya **Kahanowicz** and Ada **Estrafalaces**: The selective absorption of coloured glasses and the radiometric method for the determination of their reflective

power.—J. **Cojan**: Modification of the method of zones (Ritchey) for the determination of the aberration of optical systems. Its extension to aberrations outside the axis. A series of photographs at different determined positions is taken, and the densities measured by the microphotometer. The accuracy (0·01 mm.) is greater than that obtainable by eye observations.—F. **Guéry**: The magnetic field of the electron in movement. The conclusion is drawn that the magnetic field of the electron is only a mathematical expression without physical reality.—H. **Pied**: The precipitation of tantalum and niobium by cupferron and their separation from iron. After removal of iron as the sulphide in a solution containing oxalic and tartaric acids, tantalum and niobium can be completely separated by cupferron. Titanium, if present, is also precipitated.—Mme. P. **Ramart** and Mlle. **Amagat**: Molecular transpositions. The preparation and dehydration of some α-α-diarylethanols and alkyldiarylethanols.—Léon **Piaux**: The action of catalysts on the oxidation of uric acid: copper and cuprous urate. Both copper powder and cuprous urate serve as active catalysts in the oxidation of uric acid in alkaline solution by oxygen. Potassium oxonate and allantoin are produced.—E. **Kohn-Abrest**: The examination of blood for gaseous poisons. An apparatus is described and illustrated capable of detecting and estimating alcohol, sulphuretted hydrogen, hydrocyanic acid, carbon dioxide and carbon monoxide in 50 c.c. of blood.—Marcel **Solignac**: The eruptive rocks of the archipelago of Galite.—E. **Henrijean** and W. **Kopaczewski**: Colloids and mineral waters. A study of a ferruginous mineral water has proved the presence of a colloid in this water. From its chemical composition, this colloid can be only an electropositive hydrosol of iron.—— **d'Arsonval** and — **Bordas**: Remarks on the preceding note.—E. **Rothé** and Mme. A. **Hée**: The earthquakes observed in France during the year 1923. Fifteen earthquakes were felt in France during the year, the most important being in the Pyrenees region.—Ch. **Brioux**: The influence of urea, used as manure, on the reaction of the soil. Experiments with soil showed that urea, utilised as manure, behaves at first as an alkali on account of its rapid conversion into ammonium carbonate. As the latter is nitrified, it acts as an acid like other ammoniacal manures.—Jules **Amar**: Course of the vital coagulation.—Gabriel **Bidou**: An artificial hand or apparatus for replacing a hand after amputation.—E. **Lagrange**: A reaction of the testicular hormone.—L. M. **Betances**: New details on cytohaematogenesis.—Alphonse **Labbé**: An experimental phylogenetic race. An account of variations in some copepods produced by varying the P_H of sea water.—E. **Gley** and J. **Cheymol**: The presence of iodine in venous blood from the thyroid. It was found that the thyroid gland of the goat yielded sufficient venous blood to permit of the determination of the iodine. The blood in the general circulation also contained iodine. Whilst the proportion of iodine in the blood issuing from each lobe of the gland generally increases with the proportion of iodine in the gland itself, the two are not proportional, and there are probably other controlling factors.—H. **Lagatu** and L. **Maume**: The study, by the periodical analysis of the leaves, of the influence of manures containing lime, magnesia, and potash on the vine.—Louis **Lapicque**: The formula of electrical stimulation as a function of the time.—G. **Sanarelli**: The so-called "intestinal" anthrax. The enteric secretions of the dog, rabbit, and guinea-pig, although without action on the development of several species of organisms (Proteus, Staphylococcus, *B. mesentericus*), completely prevent the development of anthrax spores. These results throw some doubt on the views commonly held on "intestinal anthrax."—C. **Levaditi**, S. **Nicolau**, Mlles. J. **Salgue** and R. **Schoen**: The mechanism of the action of bismuth in syphilis. The destruction of the treponema *in situ* is the effect of quantities of bismuth too small to detect by chemical methods.

Official Publications Received.

United States Department of Agriculture. Department Bulletin No. 1238: The Canker-worms. By B. A. Porter and C. H. Alden. Pp. 38+3 plates. 10 cents. Department Bulletin No. 1243: Studies of the Mexican Bean Beetle in the Southeast. By Neale F. Howard and L. L. English. Pp. 51+12 plates. 20 cents. (Washington: Government Printing Office.)

University of Illinois Engineering Experiment Station. Bulletin No. 143: Tests on the Hydraulics and Pneumatics of House Plumbing. By Prof. Harold E. Babbitt. Pp. 80. (Urbana, Ill.) 40 cents.

The National Institute of Agricultural Botany. Fifth Report and Accounts, 1923–1924. Pp. 19. (Cambridge.)

Meddelelser fra Kommissionen for Havundersøgelser. Serie Fiskeri, Bind 7, Nr. 5: On the Summer- and Autumn-Spawning Herrings of the North Sea. By Dr. A. C. Johansen. Pp. 119. 8 kr. Serie Fiskeri, Bind 7, Nr. 6: Fish Eggs and Larvæ collected in the Belt Sea in March 1922. By P. L. Kramp. Pp. 19. n.p. (København: C. A. Reitzel.)

County Borough of Huddersfield. The Tolson Memorial Museum Publications. Handbook 3: Early Man in the District of Huddersfield. By James A. Petch. With an Appendix on the Nature and Making of Graving Tools, by Francis Buckley. Pp. 95. (Huddersfield.) 1s.

Commonwealth of Australia. Institute of Science and Industry. Bulletin No. 27: Australian Clays in the Manufacture of White Pottery Wares. By R. C. Callister. Pp. 87. (Melbourne: H. J. Green.) Gratis.

Meddelanden från Statens Meteorologisch-Hydrografiska Anstalt. Band 1, No. 5: Översikt över Sveriges vattenkraft. Av Sven Norlindh. Pp. viii+40+3 maps. (Stockholm.) 8.50 kr.

State of Connecticut. Public Document No. 34: Biennial Reports of the Storrs Agricultural Experiment Station, Storrs, Connecticut; including the 32nd Annual Report for the Nine Months ending June 20, 1920, 33rd Annual Report for the Year ending June 30, 1921, 34th Annual Report for the Year ending June 30, 1922, 35th Annual Report for the Year ending June 30, 1923. Pp. xiii+323. (Storrs, Conn.)

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 20, Part 13: Revision of the American Species of Rinorea; New Plants from Venezuela; Hemibaccharis, a new Genus of Baccharidinæ. By S. F. Blake. Pp. x+491-554+plates 81-51. (Washington: Government Printing Office.) 20 cents.

Field Museum of Natural History. Zoological Series, Vol. 10, No. 16: Contents and Index to Volume 10, Numbers 1 to 15. (Publication 214.) Pp. ix+375-385. Zoological Series, Vol. 15: The Marine Fishes of Panama. Part 1. By Seth E. Meek and Samuel F. Hildebrand. (Publication 215.) Pp. xi+330+24 plates. Anthropological Series, Vol. 16: Japanese Sword-Mounts in the Collections of the Field Museum. By Helen C. Gunsaulus. (Publication 216.) Pp. 195+61 plates. Report Series, Vol. 6, No. 3: Annual Report of the Director to the Board of Trustees for the Year 1923. (Publication 217.) Pp. 167-264+plates 30-46. Zoological Series, Vol. 12, No. 4: New Birds from Central Peru. By John T. Zimmer. (Publication 218.) Pp. 49-67. Zoological Series, Vol. 12, No. 5; New Birds from Chile. By C. E. Hellmayr. (Publication 219.) Pp. 69-75. Zoological Series, Vol. 12, No. 6: Notes on Central American Crocodiles. By Karl P. Schmidt. (Publication 220.) Pp. 77-92+plates 5-9. Zoological Series, Vol. 12, No. 7: New Salamanders of the Genus Oedipus, with a Synoptical Key. By E. R. Dunn. (Publication 221.) Pp. 93-100. (Chicago.)

Department of the Interior: United States Geological Survey. Bulletin 758: Bibliography of North American Geology for 1921–1922. By John M. Nickles. Pp. ii+273. 25 cents. Water-Supply Paper 516: Surface Water Supply of Hawaii, July 1, 1919, to June 30, 1920. Pp. v+159. 20 cents. Water-Supply Paper 518: Ground Water in Musselshell and Golden Valley Counties, Montana. By A. J. Ellis and O. E. Meinzer. Pp. vi+92+5 plates. 20 cents. Water-Supply Paper 520-C: Power Resources of Snake River Basin between Huntington, Oregon, and Lewiston, Idaho. By William Glenn Hoyt. Pp. ii+27-51. n.p. Water-Supply Paper 535: Surface Water Supply of Hawaii, July 1, 1920, to June 30, 1921. Pp. iv+151. 15 cents. Professional Paper 127: The Composition of the Earth's Crust. By Frank Wigglesworth Clarke and Henry Stephens Washington. Pp. v+117. 20 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Mineral Resources of the United States in 1923 (Preliminary Summary). Introduction by Frank J. Katz; Statistics assembled by Martha B. Clark. Pp. iv+130A. (Washington: Government Printing Office.) n.p.

Diary of Societies.

SATURDAY, NOVEMBER 29.

ROYAL IRISH ACADEMY, at 4.15.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section, jointly with the Mining Institute) (at Bolbec Hall, Newcastle-on-Tyne), at 7.

HULL ASSOCIATION OF ENGINEERS (at Hull Municipal Technical College), at 7.15.—W. J. Bowtell: Lifting Machinery for Docks.

SOCIETY OF DYERS AND COLOURISTS (West Riding Section).—Dr. F. M. Rowe and V. Tarbett: The Dyeing Properties of some Azo Derivatives of Tetra Hydro Naphthalene.

MONDAY, DECEMBER 1.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Monthly Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—H. A. Rickwood: Recent Developments in Ferro-Concrete Cooling Towers.

INSTITUTION OF ELECTRICAL ENGINEERS (jointly with the South Wales Institute of Engineers) (at Cardiff), at 6.—W. E. Bush: Demonstration on Modern Illumination.

JUNIOR INSTITUTION OF ENGINEERS (North-Western Section) (at 16 St. Mary's Parsonage, Manchester), at 7.15.—B. Spencer: Modern Locomotive Lubrication Practice.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.), at 8.—Prof. J. A. Smith: Prof. Alexander's Space-Time.

ROYAL SOCIETY OF ARTS, at 8.—Dr. L. C. Martin: Modern Colour Problems (II.) (Cantor Lectures).

SOCIETY OF CHEMICAL INDUSTRY (London Section, jointly with Oil and Colour Chemists' Association) (at Chemical Society), at 8.—Discussion on Protective Paint Coatings.

ROYAL GEOGRAPHICAL SOCIETY (at Central Hall, Westminster), at 8.30.—A selection from M. Albert Kahn's collection of Photographs in Natural Colours, described by A. G. Ogilvie: Physical Geography and Landscapes.—E. A. Benians: Moslem Architecture.—L. H. Dudley Buxton: Man in Relation to his Environment.—Prof. P. M. Roxby: China.

INSTITUTION OF THE RUBBER INDUSTRY (London Section) (at Engineers' Club, Coventry Street, W.).—Major B. J. Eaton: Research Work on the Plantation.

TUESDAY, DECEMBER 2.

ROYAL HORTICULTURAL SOCIETY, at 4.—Lecture.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—A. W. Nash and H. G. Shatwell: Fuel Oil Resources of the Future.—H. G. Shatwell, A. W. Nash, and J. I. Graham: The Somerset Oil Shales.

INSTITUTION OF CIVIL ENGINEERS, at 6.—R. H. L. Pennell and H. Addison: Water-Supplies to the Smaller Provincial Towns of Egypt.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—R. B. Stewart: Fire and Fire Protection.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at 17 Albert Square, Manchester), at 7.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.—W. E. Ballard: Metal Spraying.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—M. Ruot, K. C. D. Hickman, and others: Colour Stencilling and Tinting.—Messrs. Pathé: Demonstration of their Process of Colour Kinematography, in which the Film is Coloured by a Mechanical Process.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Coventry), at 7.15.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—W. D. McLaren: The Further Development of Large Power Diesel Engines.

INSTITUTE OF METALS (North-East Coast Section) (at Armstrong College, Newcastle-on-Tyne), at 7.30.—G. B. Brook: Aluminium, its Production and Uses.

RÖNTGEN SOCIETY (at British Institute of Radiology, 32 Welbeck Street, W.), at 8.15.—Prof. J. A. Crowther: Some Experiments with Induction Coils.—Prof. J. A. Crowther and R. J. Stephenson: Effect of Capacity on the Induction Coil.

WEDNESDAY, DECEMBER 3.

GEOLOGICAL SOCIETY OF LONDON, at 5.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—G. Shearing: Wireless Telegraph Valve Transmitters employing Rectified Alternating Current.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—G. Rogers: Automatic and Semi-Automatic Mercury-Vapour Rectifier Substations.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Engineers' Club, Coventry Street, W.), at 7.—H. W. S. Martin: Air Washers and Air Filters.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section) (at University College, Nottingham), at 7.30.—Prof. W. E. S. Turner: Glass.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

INSTITUTION OF SANITARY ENGINEERS (at Caxton Hall), at 7.30.—H. A. Roechling: House Drainage, with special reference to the Intercepting Trap.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—G. Van B. Gilmour: The Analytical Value of the Melting Point of the Insoluble Volatile Acids from Fats.—A. H. Ware: The Use of Mitchell's Ferrous Tartrate Reagent in Qualitative Analysis.—Dr. S. Glasstone: The Influence of Hydrogen Ion Concentration on the Colorimetric Estimation of Pyrogallol and Catechol Derivatives.—B. S. Evans: The Futility of Sealing: A Suggestion for its Safeguarding.

ROYAL SOCIETY OF ARTS, at 8.—Prof. C. A. Carus-Wilson: The Teaching of Science in Secondary Schools.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, DECEMBER 4.

ROYAL SOCIETY, at 4.30.—Prof. A. Fowler: The Structure of the Spectrum of Ionised Nitrogen.—Dr. H. Jeffreys: The Formation of Water Waves by Wind.—J. E. Jones: (1) The Determination of Molecular Fields. III. From Crystal Measurements and Kinetic Theory Data. (2) On the Atomic Fields of Helium and Neon.—F. S. Tritton: A Centrifugal Method of making Small Pots of Electrically Fused Refractory Materials.—*To be read in title only*:—Prof. J. W. Nicholson: Spheroidal Wave Functions.—J. V. Howard and S. L. Smith: Recent Developments in Tensile Testing.—F. C. Harris: The Photo-Elastic Constants of Glass as affected by High Temperatures and by Lapse of Time.—Prof. A. L. Narayan and D. Gunnaiya: Absorption and Dispersion of Thallium Vapour.—R. d'E. Atkinson: Note on Vegard's Theory of the Aurora.—Mollie Weinberg: The Spark Spectra of Indium and Gallium in the Extreme Ultraviolet Region.—S. W. Richardson: The General Law of Electrical Conduction in Dielectrics.—T. Lewis: The Interpretation of the Results of Bucherer's Experiments on e/m.—A. M. Mosharrafa: The Quantum Dynamics of Degenerate Systems.—E. G. Dymond: The Precise Measurement of the Critical Potentials of Gases.—I. Langmuir and K. H. Kingdon: Thermionic Effects caused by Vapours of Alkali Metals.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. G. C. Druce: Exhibition of *Epipogum aphyllum*, and other British Plants.—Miss V. Hay: The Adult and Juvenile Forms of *Sophora tetrap'era* vars. *microphylla* and *prostrata*.—Miss V. M. Grubb: The Development and Liberation of Spermatia in some previously undescribed cases.—Prof. E. S. Goodrich: The Cranial Roofing-bones in Dipnoi Fishes.

ROYAL AERONAUTICAL SOCIETY (at 7 Albemarle Street, W.), at 5.30.—Col. F. Searle: The Maintenance of Commercial Aircraft.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. Octavia Lewin: Some Physical Causes of Mental Deficiency.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Prof. J. G. Gray and J. Gray: Gyroscopic Pendulums.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (at Bristol University), at 7.30.—W. E. Fearnsides: Some International Aspects of the Dye Industry.

INSTITUTE OF METALS (Sheffield Section, jointly with the Silver Trades Society) (at Sheffield University), at 7.30.—A. Jefferson and others: Discussion on Electro-Plating.

CHEMICAL SOCIETY, at 8.—H. Burgess and Prof. T. M. Lowry: (*a*) New Halogen Derivatives of Camphor. Part VI. β-Bromocamphor-α-Sulphonic Acid; (*b*) New Halogen Derivatives of Camphor. Part VII. The Constitution of the R-ychler Series of Camphorsulphonic Acids. Experiments on Chlorosulphoxides.

ROYAL SOCIETY OF MEDICINE (Dermatology, Laryngology, and Odontology Sections), at 8.—J. F. O'Malley, Dr. H. W. Barber, and others: Discussion on Focal Sepsis in relation to Diseases of the Skin.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Section).—Report of the Marine Oil-Engine Trials Committee.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Section).—Report of the Marine Oil-Engine Trials Committee.

FRIDAY, DECEMBER 5.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Lt.-Col. R. McCarrison: Problems of Food, with special reference to India.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Col. H. G. Lyons and Sir G. P. Lenox-Conyngham: The Use of Submarines in the Determination of Gravity at Sea. Chairman: Prof. G. I. Taylor.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—Dr. P. Lewis-Dale: Liquid Hydrocarbons obtained in the Compression of Oil Gas.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. F. C. Lea: The Effect of Low and High Temperatures on Materials.—J. M. Lessells: The Elastic Limit in Tension, its Influence on the Breakdown by Fatigue.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—L. Wood: Matters Pictorial.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—A. V. Slater: Peptisation.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. B. Pollard: Metal Cutting under Water by the Oxy-acetylene Blow Pipe.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Cleveland Institution, Middlesbrough), at 7.30.—L. W. E. Rowbotham: Constructing a Ship.

PHILOLOGICAL SOCIETY (at University College), at 8.—R. J. Whitwell: Future of N.E.D.

INSTITUTION OF MECHANICAL ENGINEERS (Liverpool Section).—Report of the Marine Oil-Engine Trials Committee.

SATURDAY, DECEMBER 6.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—E. W. H. Piper: Durham Cathedral (Lecture).

INSTITUTE OF BRITISH FOUNDRYMEN (at Chamber of Commerce, Birmingham), at 4.—D. Wilkinson: Malleable Iron.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 29.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—S. H. Warren: Prehistoric Man and the "Land of Lyonesse."

TUESDAY, DECEMBER 2.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: The Philosophy of the Absolute in English Thought: The Eternal and the Temporal.

WEDNESDAY, DECEMBER 3.

MEDICAL SOCIETY OF LONDON, at 5.15.—Dr. W. M. Feldman: Post-Natal Child Physiology and Hygiene (Chadwick Lecture).

UNIVERSITY COLLEGE, at 5.30.—I. Björkhagen: Sweden: Its Land and People.

THURSDAY, DECEMBER 4.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Dr. J. F. Spencer: The Historical Development of Conception of the Atom.

KING'S COLLEGE, at 5.30.—M. Beza: Pagan Remnants in Roumanian Folklore. (Succeeding Lecture on December 11.)

FRIDAY, DECEMBER 5.

KING'S COLLEGE, at 5.30.—Dr. E. S. Russell: Scientific Method.

SATURDAY, DECEMBER 6.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: The Eggs of Animals.

NATURE

SATURDAY, DECEMBER 6, 1924.

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Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

The Development of Industrial Research Associations.

MANY of the Research Associations, founded under the auspices of the Department of Scientific and Industrial Research, have been in existence for five years, and consequently it is possible to form some idea of their future development and usefulness.

The reasons for their establishment are well known. It was recognised that British industries are in the main highly developed arts and crafts, basing their technical methods on slowly gained practical experience rather than on the broader foundations afforded by scientific method. The knowledge in any industry consists of a number of well-established but often unrelated facts; what is lacking is the scientific substratum which binds these facts into a coherent whole.

It must be clear to all who have given thought to the subject, that industries established in this manner now find that, before much further advance can be made, problems of such a fundamental and purely scientific nature have to be faced that no single firm could undertake their solution. Generally speaking, British industry in the past has fought shy of research, especially of the more fundamental kind. The necessity for it is, therefore, all the more pressing. Fortunately, industrial leaders have a growing belief in its utility, and are readier than ever before not only to avail themselves of the results that research can place at their disposal, but also to bear its cost. The only debated point with them has been the nature of the scheme to be adopted in order to bring about the desired end. In these circumstances it is hard to conceive a better plan than that evolved by the Department of Scientific and Industrial Research, since for the first time it enables fundamental problems to be worked on by an Association representative of, and supported by, the whole industry, which is ready to pool its experience and place it at the disposal of the scientific workers who are responsible for carrying out the investigations.

Probably, if Research Associations did not exist, British industry would still be chary of recognising its obligation to undertake fundamental research work, and the fact that industrial belief in Research Associations is undoubtedly spreading, constitutes one of the strongest arguments in favour of the creation and continuance of these bodies.

Research Associations have many advantages over academic research institutes in attacking industrial problems which, as a rule, are many-sided scientifically, and require not only deft handling by an expert in any one science, but also organised and co-operative attack by experts in several sciences. Nor does the matter end here, for when the scientific data are ascertained

and the laboratory solution has been found, there still remains what is often the most difficult and costly part of the work, namely, the application to large-scale practice. Neither the man of science nor the technologist can, individually, handle this side of the question successfully: the closest co-operation is necessitated, in which the technical side must be represented by both employers and employed. The future success of Research Associations largely depends on the reality and effectiveness of this co-operation.

Far-reaching inquiries into the scientific foundations of industrial practice are not, however, likely to bear fruit in a brief period of time; and on this account great faith and patience are required on the part of those who are supporting them. How are this faith and patience to be created? The hard-headed business man with no knowledge of scientific method would not be won over by the statement "subscribe to the Association for five, ten, or perhaps fifteen years and good will come to you." He is, however, strongly appealed to when he sees everyday difficulties surmounted, and newly discovered facts, which probably at first he regarded with little interest, usefully applied in unexpected directions. The gradual accumulation of scientific data should make it comparatively easy for Research Associations to give this form of assistance.

This raises the question, to what extent should Research Associations do consulting work? This is undoubtedly not their prime object; yet it seems inevitable that some work of this description will have to be undertaken, for as the confidence of a trade in its Association increases, so naturally will the desire of the former to refer more and more of its difficulties to the latter. Moreover, the solution of these minor problems is of undoubted educational value to the scientific staff of an Association, who, as they are devoting their whole energies to the scientific side of a trade, must eventually become "the" authorities in their respective branches. The relative amount of such work to be undertaken must be left to the decision of the governing body of each Association, but the most useful test to apply in relation thereto should be: Is the particular point raised of importance to the trade in general, or does it affect one firm only? If the former, the work might well be done and the solution given to the trade as a whole. But it must never be forgotten that, although this kind of work can greatly improve general efficiency, it is unlikely to effect a revolution in any industry. Really great advances can only result from the discovery of new starting-points, which will be established by probing more deeply into the intrinsic properties of the raw materials employed, and by laying bare the scientific principles involved in each process of manufacture.

Five years—the first period of Government support to the Research Associations—is certainly too short a time in which to prove the value of fundamental scientific work to those who have never had any knowledge of its possibilities, especially when the scientific staffs of Research Associations have had to acquire a considerable knowledge of technical detail of the industry, and perhaps the additional five years, for which new grants have been made, may not prove adequate to allow the Associations so to gain the confidence of their trades as to render outside assistance no longer necessary. It is, however, at once granted that such must be the ultimate goal, and there seems little doubt but that the goal will be reached. In support of this statement no more striking example could be quoted than that of the cotton industry, the members of which have recently proved their faith in co-operative research by agreeing to double their subscriptions to their Association and to guarantee them for five years. The Cotton Research Association has now an assured income of more than 40,000*l.* a year, and although this sum may be considered small for an industry of the magnitude of that concerned with cotton, and further, may not be sufficient to allow the fullest possible developments at the moment, it is at least sufficient to demonstrate the value of what may well prove to be one of the greatest movements in the advance of modern British industry.

It is hoped that many of the trades which have entered into the scheme may reap early benefit as a result of their foresight, but the main object in the founding of Research Associations was surely not so much consideration for the immediate present, as a desire to associate science with industry in such a manner that the future would show the continued supremacy of British trade, on which the welfare of the nation depends.

KENNETH LEE.

The Life of Lord Rayleigh.

John William Strutt, Third Baron Rayleigh, O.M., F.R.S., Sometime President of the Royal Society and Chancellor of the University of Cambridge. By his Son, Robert John Strutt, Fourth Baron Rayleigh. Pp. xi+403+5 plates. (London: E. Arnold and Co., 1924.) 25*s.* net.

LORD RAYLEIGH has completed a very difficult task with great success; he has written a life of his father which has the intimacy which only near relationship could give, combined with a frankness which leaves the conviction that he has shown true filial piety by omitting nothing that would help to make his portrait of a very great man true to life. He says in the preface that it has been his aim not so much

to give an account of his father's scientific work as to depict him as a man. He tells us about his father's boyhood, how he went first to Eton and then after an interval to Harrow; bad health, however, prevented him from staying more than a term or two at either. The greater part of his school education was at Mr. Warner's, a well-known private school at Torquay, a school by the way where no unmarried lady of less than sixty years of age was to be mentioned at the dinner table. The love for a joke, which Rayleigh never lost, began soon, for we find from a letter written at school that he and another boy invented a language which they called Russian, and set the smaller boys at work learning the declensions. The mathematical teaching at Warner's seems to have been good, and Rayleigh remained there until within a few months of going up to Trinity College, Cambridge. As a boy he was very fond of photography, which he began at about the time when he went to Warner's, and he often in after life declared that he owed much to the practice he got in manipulation with the old wet collodion process.

Between the spring of 1861, when he left Warner's, and the October of the same year, when he came to Trinity, Rayleigh began with a private tutor to read the differential calculus, so that his stock of mathematical knowledge as a freshman was a great contrast to that of Lord Kelvin, who had written papers on Fourier's theorem before coming to Cambridge; it was, however, greater than that of Stokes, who had not commenced the differential calculus when he came into residence. At the time when Rayleigh was an undergraduate, the teaching of mathematics to the best men was very largely in the hands of Routh. College lectures counted for little, and professor's lectures for still less. Routh's method of teaching was as different as possible from the popular idea of private coaching. It consisted of admirably clear and carefully prepared lectures given to a class of perhaps ten or twelve pupils. Many examples were set for solution, and each week there was a problem paper the marks for which were made public so that it acted as an incentive. Lord Rayleigh expressed in a speech quoted in his biography the gratitude which he and many other pupils felt to Routh for his teaching. At Routh's the physics were in abeyance, and when in his third year Rayleigh attended Stokes's lectures on optics, it was an epoch in his life. "This was what I really liked," he said many years afterwards, quoting from his note of Stokes's lectures: "a beam of coloured light was passed through a dilute alcoholic solution of the green colouring matter of leaves; the transmitted rays were green, but the part of the liquid traversed by the rays shone with a deep blood-red light."

Rayleigh prepared with great care for the tripos examination, going so far as to study the idiosyncrasies of the examiners so as to form some idea of the questions they were likely to set. Like others before and after him, he was reduced to despair by the problem paper in the first part of the tripos: a diabolical contrivance full of "low mathematical dodges." However, all went well in the end, and he came out senior wrangler and first Smith's Prizeman in January 1865. Marshall, the political economist, was second wrangler, and H. M. Taylor third. Some of Rayleigh's answers were so good that one of the examiners said they might have been sent straight to press without correction. The correspondent of the *Times*, in announcing the result of the tripos, said that "the success of Mr. Strutt is attributed more to his perseverance than to his brilliant talent"! It is disconcerting to find that when at Trinity the future Chancellor indulged in roof-climbing about the College, a practice which now at any rate is not regarded with favour by the authorities. He also played real tennis; one result of this was his delightful little paper "On the irregular flight of a tennis ball."

After taking his degree Rayleigh found great difficulties in getting opportunities for experimental research or instruction in laboratory work. This, he said afterwards, "wasted three or four years of my life." In 1868, after a trip to America, he started experimenting on his own account at Terling, and in the course of the next ten years published, along with many other things, papers on the theory of resonance, on the scattering of light by small particles, on the resolving power of optical instruments, and his great book on the "Theory of Sound."

When on Clerk-Maxwell's death in 1879 the professorship of experimental physics at Cambridge became vacant, Lord Rayleigh received an invitation, signed by 125 members of the Electoral Roll, inviting him to become a candidate for the professorship. After considerable hesitation he accepted the invitation and was elected to the professorship in December 1879. He began at once to reorganise the laboratory and the teaching. Finding the supply of apparatus inadequate, he raised a fund of 1500*l.*, towards which he gave 500*l.*, for buying more. In collaboration with Glazebrook and Shaw he organised a system of teaching practical physics which is in essentials the same as that still in force. His own work before coming to Cambridge had not been especially on electrical subjects; but, as he told me, he found that the interest which Maxwell had aroused in electricity was so strong that he was led himself in the same direction. He organised and carried out, with the assistance of Mrs. Sidgwick and Sir Arthur Schuster, those classical determinations of the fundamental electrical units which raised electrical measurements to a new level. An admirable account of these investigations is given in the

biography. In starting the work on electrical units he had in his mind a scheme of identifying the laboratory with a research planned on an extensive scale in which a large number of workers in the laboratory might take part. I think it is doubtful whether, considered from the point of view of training for young physicists, such a scheme is advantageous in a university laboratory. Most men are much more interested in, and more enthusiastic about, one branch of physics than another, and a young man develops his powers more rapidly and puts more independent thought into his work if he tackles a problem which he has, to some extent, selected for himself, than if he joins a scheme of work already planned.

As one who worked in the laboratory while Lord Rayleigh was professor, I can testify to the assistance we got from him; there never was, I think, a man whose judgment in scientific matters was sounder or more free from prejudice; if he questioned a conclusion or a result one felt there was a real difficulty which required further investigation. Yet even with these qualities he found prophecy was not free from danger. He says in a letter written at this period: "Yesterday I had an opportunity of seeing the telephone which every one has been talking about . . . it is certainly a wonderful instrument, though I suppose not likely to come to much practical use." Having quoted a bad guess I ought not to omit a good one in his presidential address to the Royal Society in 1908. He says: "We may expect to see flying machines in use before many years are past."

Lord Rayleigh had only undertaken to hold the professorship for five years, and at the end of 1884 he resigned. In spite of attacks of rheumatic fever he had worked desperately hard and published sixty important papers in five years. Mr. Gordon, who had been his assistant at the Cavendish laboratory, went with him to Terling; it is pleasant to find in the biography kindly reference made to Gordon, who, by the assistance he gave to Lord Rayleigh, rendered good and faithful service to science.

On leaving Cambridge in 1884 Lord Rayleigh continued his experimental work in his laboratory at Terling. The absence of the facilities of a large laboratory would have been a serious handicap to most men, but Lord Rayleigh possessed to an extraordinary degree the power of getting important results with simple apparatus: it has been said of him that he only required a few pieces of glass tubing and a stick of sealing-wax to make the most fundamental discoveries. It was immediately after leaving Cambridge that he began the work which led to his discovery of argon and incidentally caused him much annoyance. The story of the discovery of argon is told by his son in a chapter which is a masterpiece of clear and impartial statement; every line carries conviction, and after reading it we are convinced that there is nothing further to be said on the subject. The discovery of argon is a most striking instance of the necessity of utilising physical methods in chemical analysis—what can they know of chemistry who only chemistry know?

Besides his almost unparalleled activities in research, Lord Rayleigh did no inconsiderable amount of official and executive work. These aspects are dealt with in the biography in a chapter on "Public Work": a very clear and interesting account of the foundation of the National Physical Laboratory is given, and the debt which that laboratory owes to him is certainly not overestimated. He was the chairman of the Treasury Committee which in 1898 reported in favour of establishing the laboratory, and he was chairman of the executive committee to which it was entrusted from the time of its formation until shortly before his death. His judgment, his wisdom and his influence contributed in no small measure to the growth of that institution from very modest beginnings to the foremost place among National Physical Laboratories. His work at the Royal Society, at the Royal Institution, as scientific adviser to Trinity House, and as gas referee, are admirably described.

Not the least interesting part of the book is the account of Lord Rayleigh's connexion with psychical research. As a young man he realised the immense importance of the subject, and it is stated in the biography that he contemplated throwing the greater part of his energies into the investigation of such problems. He says in a letter written in 1874: "A decision of the existence of mind independent of ordinary matter . . . would be the most important possible scientific discovery." He attended many seances, but came, as others have done, to the conclusion that he was unlikely from his own personal experience to be able to arrive at conclusions definite enough to justify him in making it his life work. In his presidential address to the Society for Psychical Research a few months before his death, and showing that clearness of thought and perception of essentials so characteristic of him, he offers no definite opinion, but says: "Some of those who know me best think that I ought to be more convinced than I am. Perhaps they are right."

Lord Rayleigh was a lover of good stories, and a list of some of those which appealed to him is given in an appendix to the biography. This is a novel feature in a book of this kind, but it makes us, I think, feel we know him better than if it had been omitted.

Lord Rayleigh has been fortunate in his biographer, for no one can read this admirably written work without increased admiration and respect for one of the great names in British science, a great discoverer and a counsellor whose judgments were never clouded by prejudice or by a shadow of self-seeking. J. J. THOMSON.

Practical Farming.

(1) *The Production of Field Crops: a Textbook of Agronomy.* By Prof. T. B. Hutcheson and Prof. T. K. Wolfe. (McGraw-Hill Agricultural and Biological Publications.) Pp. xv+499. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 17*s.* 6*d.* net.

(2) *Grassland Farming, Pastures and Leys.* By W. J. Malden. Pp. xxiv+314. (London: Ernest Benn, Ltd., 1924.) 30*s.* net.

THE agricultural industry is passing through a critical period not only in Great Britain but also—if for very different reasons—in the United States of America. It would almost appear as if these difficult times are operating to bring the man of science and the man of practice closer together, and as if the movement in the direction of universal agricultural education and research, quickened by the stress of adversity, is on the threshold of bearing very substantial fruit. It is a noteworthy fact that the later post-War period has been remarkable for the appearance on both sides of the Atlantic of a large number of books on agricultural subjects. There has been discernible in many of these books a tendency to write as much, or more, for the benefit of the farmer as for the enlightenment of the student.

This tendency is well exemplified in the two volumes under notice, and is shown by nothing so much as the fact that the chapters are not burdened with attempts to teach elementary chemistry or elementary botany or with digressions in the realm of pure science irrelevant or more or less irrelevant to the subject matter. The subjects under discussion are dealt with from the practical point of view and with resort to the minimum of technical terms. It is presumably coming to be realised that the farmer does not wish to be taught the technicalities of science, but he demands that the practical information and advice given him shall be both correct and sound; it must therefore be based on accurate scientific knowledge born of experimentation, and should be backed by prolonged farming experience.

(1) The work of Profs. Hutcheson and Wolfe constitutes the nineteenth of the excellent series of agricultural and biological publications of which Dr. Charles V. Piper is the consulting editor, and is based almost entirely on the results of properly conducted field trials.

The authors state that the standard introductory course in field crops recently adopted by the American Society of Agronomy (see Journal of the American Society of Agronomy, vol. 14 (4), April 1922; vol. 15 (2), February 1923; and vol. 16 (1), January 1924) has been followed as closely as practicable. The work is therefore essentially a text-book adapted for the use of American farmers and students, and deals explicitly with American conditions. This is emphasised by the fact that of the 396 citations in the bibliography, all except about a dozen refer to American investigations.

The book should be of considerable value, however, not only to the British student seeking accurate information with reference to American crops and to American literature, but also to such as desire concise information, based on scientific investigation, as to the fundamentals of successful crop production. Thirty-seven of the forty-five chapters are devoted to a general discussion of the culture of crops. In addition to subjects like tillage, fertilisers, and lime, which in the past have so largely dominated works on crop production, it is significant of the American point of view that no less prominence is given to the treatment of the factors more or less inherent in the crop itself, such as the adaptation of crops, crop improvement, and the value of good varieties and of good seed. The part that seed associations of farmers have played in the distribution of improved or suitable varieties and of good seed, based on the extensive trials undertaken by the Experimental Stations, is emphasised in these chapters and should afford food for thought to the British agriculturist. Similarly the chapter on grain grading directs attention to an important question which has recently been given much prominence by the teachers of farm crops in the various agricultural colleges in the United States. Grassland is adequately dealt with in chapters on haymaking, pasture, and meadow management.

The chapters on the individual crops are enhanced in value by maps indicating the geographical range of cultivation of each within the United States, and in the case of the more important crops the belts devoted to certain groups of varieties in particular are also shown, while statistics are given both as to world production and to production within the United States.

(2) Mr. Malden's volume on grassland farming is severely practical, and the information supplied, although supplemented by references to numerous trials, is based largely on the author's considerable experience of farming. That the results of exact experimentation have not been more extensively drawn upon, or at all events not more extensively relied upon, is perhaps in the main to be accounted for by the simple fact that very little experimental work bearing explicitly on the management of grassland as a whole—as opposed to experiments on isolated aspects of grassland husbandry, such as manuring, seeding-down, and the like—has been conducted in Great Britain. In several instances,

however, the author undoubtedly attaches more importance to his own interpretation of his own experiences than to the largely accepted teaching of more or less recent experimental trials. This is noteworthy in respect of his paragraphs relative to the feeding of cake on grassland, and as to the use of inorganic nitrogenous fertilisers on pastures; it is also apparent that the author has a decided predilection in favour of the so-called complicated mixture. Thus on p. 87 he quotes and apparently approves of a seeds mixture for light land consisting of sixteen species, no less than four of which are included in amounts of less than 1 lb. It is true that at the end of the chapter on seeds mixtures he quotes, but without comment, those of a simpler character recently advocated by the Royal Agricultural Society.

In the chapter "Plants of Permanent Pasture" valuable and concise information is given relative to the chief species; it is unfortunate, however, that the author perpetuates the term "cow-grass" for single cut cow grass or late flowering red clover, and that he also quotes without contradiction the time-worn view that this strain of red clover originated from crossing *Trifolium pratense* with *T. medium* or zigzag clover, a view for which there is no possible botanical justification.

The chapters on the management of temporary and permanent pastures are exceedingly interesting and very suggestive, while that on haymaking should be read with the greatest care by every farmer who operates in regions of high rainfall. R. G. S.

The Manufacture of Sulphuric Acid.

(1) *The Manufacture of Sulphuric Acid (Chamber-Process)*. By W. Wyld. ("The Manufacture of Acids and Alkalis," by George Lunge. Completely revised and rewritten under the Editorship of Dr. A. C. Cumming. Vol. 2.) Pp. xii+424. 31*s.* 6*d.* net.

(2) *The Concentration of Sulphuric Acid*. By J. W. Parkes. ("The Manufacture of Acids and Alkalis," by George Lunge. Completely revised and rewritten under the Editorship of Dr. A. C. Cumming. Vol. 3.) Pp. xii+394. 31*s.* 6*d.* net.

(London and Edinburgh: Gurney and Jackson, 1924.)

THERE is no treatise in any language which gave more detailed accounts of the manufacture of sulphuric acid than that of Lunge. The earlier editions of this were based directly on the experience of the author and were very practical. In the course of revision the new matter took the form of extracts from patents, and very little critical discussion of these was added. In the latest edition, two volumes of which form the subject of the present review, there is considerable difference in the method of treatment.

(1) The new volume dealing with the chamber process is essentially the same as the later editions of Lunge, but a fair amount of the text of these has been omitted. The new matter added consists mainly of rather sketchy descriptions of pumps for acid and of patent packings for towers. The practical details of construction and working remain essentially those of Lunge, so that the larger volume of the previous edition will remain perhaps the more complete account of the subject. The new diagrams also are of a sketchy character, *e.g.*, that on p. 83 representing a tower system used by Mr. Wyld. The description of this occupies only about half a page, and the diagram is merely a rough sketch. The description of tower systems consists mainly of brief extracts from patent specifications.

Mr. Wyld states in the preface that he is himself carrying out extensive investigations on tower plant, and it would seem that it would have been wiser to have deferred the publication of this volume of the series until information of practical value had been obtained. Even if the book is to be considered merely as a collection of patent references, then it must be regarded as incomplete. The lack of detailed new information may be merely an indication that the chamber process has not been found capable of improvement, but there was obviously need for a fuller and more critical discussion of the newer tower systems. It is assumed that all the references given in the former edition have been checked with the originals; some were incorrect, and at least one is incorrect in the present edition.

(2) Mr. Parkes's volume dealing with the concentration of sulphuric acid is a very decided improvement of the previous edition of Lunge's book and contains a large amount of new information of great practical value. Much of this is derived from the experience gained during the War in the national factories. The admirable methods of control used in these factories have resulted in the accumulation of a large amount of important and useful information which is now collected, arranged, and critically discussed in one volume.

There can be no doubt that Mr. Parkes's book will be the standard treatise on the concentration of sulphuric acid. The densities are given in accordance with Domke and Bein's work, and the thermal data are collected from the critical memoir of Prof. A. W. Porter. The calculations based on these figures are therefore the most accurate available, and the results may be safely assumed as a basis of plant design. The newer types of concentrating plant, such as the cascades of various materials, the Gaillard tower, the Gilchrist apparatus,

and the modern Kessler plants, are described in full detail, with excellent working drawings and reproductions of photographs of actual plant. The condensation of fumes, a most important part of the operation of a concentration plant, is discussed, and the Cottrell and Calder-Fox systems described. The recovery of waste acid and the transport of acid are also included.

Mr. Parkes's revision has been thorough, and his book is a complete treatise on the theory and practice of the concentration of sulphuric acid. J. R. P.

Psychology as a Science.

The Nature of Intelligence. By Prof. L. L. Thurstone. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xvi+167. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co. Inc., 1924.) 10*s.* 6*d.* net.

THE fact which is, perhaps, most obvious to readers of psychological literature is that each School uses language which is entirely unmeaning when applied to another School; the behaviourist, the experimentalist, the psychiatrist, and the academic psychologist all appear to be talking in different languages, and Prof. Thurstone attempts both to unravel the reasons of the medley and also to construct an intelligible science out of it. His book is thus the first real attempt to bring into a composite whole the different branches of psychology and, for that reason alone, commends itself to all serious students.

Prof. Thurstone finds the chief reason of the differences to be that the specialists lay stress on diverse entities in conduct; they look at the subject from entirely dissimilar points of view, and (in the author's view), wrongly, build up a science which is not really true to the facts. Thus the behaviourist stresses "overt conduct," the experimentalist mere stimulus and response, the academician "consciousness and its states," and the psychiatrist abnormal psychology. The author, however, would combine the different points of view and, by shifting the stress of the special branches, construct a science at once more human and accurate.

Our author begins by showing how the stimulus-response theory must give way to the theory that impulses generate in the organism and only use stimuli in so far as they are able to satisfy the feeling generated by the activity. He then goes on to show that consciousness is an evolutionary development the sole use of which is that it leads to activity and thereby helps to gain the object desired. But this is not enough. After consciousness and its states we must have the overt act, the behaviour of the organism in order to complete the cycle. Thus a complete view of psychology begins with the "energy-source" in the individual, passes through consciousness by means of ideation to the external stimuli, proceeds to the overt act, and ends with the satisfaction of the impulse and the quiescence of the "energy-source." Looked at from this basis, intelligent conduct depends upon whether it is possible for the individual to focus in consciousness at an early stage of the impulse the specific universal meaning of the impulse and thereby make use of "trial and error" conduct. Grades of intelligence are grades of powers of inhibition, powers, that is, effectively to control mere reflex actions in order better to satisfy the impulse.

We cannot enter into details of the book. It is doubtful whether Prof. Thurstone really means the phrase "consciousness is unfinished conduct"; if he does, then he is severely limiting the use of the word "consciousness" and his definitions, both of consciousness and intelligence, appear to savour of descriptions, and, at any rate, are both debatable. The book, however, is simply written and is illuminated by profuse and clear diagrams, and his theory is backed up by a wealth of good psychological examples. It should be read, if only as a stimulus to thought and to give a clear view of the real need for a science which will combine the different branches of psychology.

Cotton in Australia.

Cotton in Australia: the Possibilities and the Limitations of Australia as a Cotton-growing Country. By Richard Harding. Pp. xviii+270. (London: Longmans, Green and Co., 1924.) 12*s.* 6*d.* net.

THE author describes this book as the result of eighteen months' investigation made in Australia, when secretary of the British Cotton Delegation, 1922. He sets out to prove that great areas of that continent can produce cotton commercially; of course he succeeds. At first one is inclined to resent the facile optimism of the fourth chapter, which is especially devoted to this proof, where the author openly omits a drought year from his averages and guesses the available resources in six significant figures; but having duly discounted his rather uncritical attitude, we can welcome this book as the first available general statement of the Australian cotton position. That the country has large potential cotton areas is clear; the Government proposes to face the basic difficulty of getting labour for the picking season (from white men in a cotton-growing climate) by planting many small areas, each on one man's small holding. Whether the plan will work remains to be seen, but Mr. Harding certainly puts his finger on two essentials; one is the cultivation of a big boll type, since the labour of picking a given weight of crop is almost inversely proportional to the boll weight; the other is the advisability of insisting

on quality, though we think he perhaps overrates here the agricultural virtue of the white as compared with the coloured man.

Structurally the book is weakened by a dual purpose. Not only does it present Australian cotton to the rest of the world—for which we welcome it, though more explicit references to sources of data would be useful—but it has also another purpose; and both would have been better achieved by shuffling the chapters into two parts. This second purpose, not explicitly stated by the author, is the presentation of the world's knowledge of cotton to the Australian; and this is necessarily a compilation. Some obsolete matter and ancient tags are included in the first two chapters, which are of dubious value; we have often heard previously of Lancashire's climate (p. 19) and men of business (p. 18); the point is missed that the Nigerian cotton supply to us is merely surplus production from their own local cotton industry (p. 23); and the artificial silk industry is making long-distance predictions of cotton consumption (p. 28) rather risky. The chapters on seed supply and cultivation, which have the same instructive aim, are of real use; the author describes some procedures which certainly ought to be followed as if they commonly were followed, thus giving a valuable tinge of practical idealism, perhaps deliberately, to his exposition. Some statistical and descriptive appendices, also of dual purpose, complete the book, which, though in many ways unsatisfactory, will be useful not only in Australia, but also outside. W. LAWRENCE BALLS.

Our Bookshelf.

(1) *The Common Sense of the Theory of Relativity.* By Dr. Paul R. Heyl. Pp. 44. (Baltimore, Md.: Williams and Wilkins Co., 1924.) n.p.

(2) *Relativity for Physics Students.* By Prof. G. B. Jeffery. Pp. vii+151. (London: Methuen and Co., Ltd., 1924.) 6*s.* net.

(3) *The Foundations of Einstein's Theory of Gravitation.* By Erwin Freundlich. Translated from the Fourth German edition, with Two Essays, by Henry L. Brose. Second edition, revised and enlarged. Pp. xvi+140. (London: Methuen and Co., Ltd., 1924.) 6*s.* net.

(4) *Darstellung der Relativitätstheorie im Dreidimensionalen Lobatschefskijschen Raume.* Von Prof. Vladimir Varićak. Pp. x+104. (Zagreb: Zaklada Tiskare Narodnih Novina, 1924.) n.p.

HERE are four more books on relativity, ranging from the highly popular and amusingly written booklet of Dr. Heyl to the extremely technical and ponderous representation of the theory in three-dimensional Lobatschefsky space. (1) The common sense of relativity can apparently be expounded in 44 pages of light reading for the man in the street, but naturally this is possible only by a use of analogies which must not be too closely scrutinised. We doubt whether it is actually "common sense" which is content to be fobbed off in this way. Nevertheless, as a booklet for whiling away a half-hour's railway journey, it is admirable.

(2) Prof. Jeffery's book is on a different plane. It introduces the theory to students of science capable of using their mathematics to a moderate extent as an instrument of thought, but not yet fully equipped with the mathematical weapons required for the thorough investigation of the subject. The result is an excellent little book which we trust all science students still nervous and suspicious of a field apparently subversive of their training, will study carefully. The ideas are clearly and concisely expounded before any mathematical treatment is entertained, and even then the analysis is economised to correspond closely to the object in view.

(3) That the translation of Freundlich's book is worth study there can be no doubt, but it is needlessly difficult to read, not so much because it is a translation but because so much more has been included between the covers than the original work. An introduction by H. H. Turner (8 pp.), followed by the material giving the title to the book (68 pp.), then 28 separate notes to this material (36 pp.), and tacked on at the end two essays by the translator (35 pp.), all contribute to produce a lack of homogeneity and the impression that the same courses are being served up several times under different guises.

(4) This is an interesting and lucid analysis of Lobatschefsky space, displaying its properties in such a form as to present their intimate relationship with the ideas of relativity.

Everyday Physics. By H. E. Hadley. Pp. viii+474+4 plates. (London: Macmillan and Co., Ltd., 1924.) 6*s.* 6*d.*

THE headmaster of a secondary school has to solve the problem of providing a satisfactory course of general science for the average pupil (including the budding specialist in language or history) along with a course which will equip a student of science for an advanced course in chemistry and physics. The chemistry of air and water, so far as it is necessary for the study of geography and botany, is taught in most schools in Great Britain to boys and girls alike, and presents no great difficulty; but the subject of physics, which is subdivided by examining bodies into three heads, becomes a Cerberus guarding the gate of a sound general education. To pass an examination *either* in heat, light, and sound, *or* in mechanics, *or* in electricity and magnetism may give admittance to the gate of the School Certificate, but that is not quite the same thing. It is undesirable that any boy should leave school without an acquaintance with the main facts of all three, and this is essential to the specialist in science.

The course in general physics outlined by the University of London provides an opportunity for a wider study of physics in the elementary stages, and is suitable for both classes of candidates. Experienced schoolmasters have already found that boys who have passed in the general physics paper are better equipped for an advanced course in science than those who have followed a more intensive course in one branch of physics only. The mathematical difficulties of such matters as lenses and specific heats are not formidable to older students who have made some progress with their mathematics, and if the earlier work is based on

sound teaching of facts and the exact meaning of words, the theory can follow later with greater appreciation.

For such an early course Mr. Hadley's book is eminently suitable. The author's name is a sufficient guarantee of its soundness to those who know his other books. The illustrations are good and for the most part new, and the number of modern appliances described and explained is remarkable. Some attention has been given to the historical side; but among the great names which appear in the index in thick type we have been unable to find Kelvin, Clerk Maxwell, and J. J. Thomson, although wireless telegraphy and atomic structure are treated with some fulness.

Hyper and Ornate Magic Squares, 15th and 16th Orders. Constructed by Major J. C. Burnett. Pp. 36. (Grantham, Lincs.: The Author, Barkston, 1924.)

MAGIC SQUARES having certain properties were known to the ancients. In modern times they have been studied by mathematicians since Albrecht Dürer's celebrated magic square picture of 1514. A magic square of order n involves in its cells the first n^2 natural numbers in such manner that the sum of the numbers in each row, column and diagonal is the same. Certain of these termed "pandiagonals" introduce the broken diagonals possessing the same additive property. If also every pair of numbers equidistant in a straight line from the centre have the constant sum n^2+1, the squares are further specified as associated or symmetrical. Squares are said to be doubly magic if the properties held show the numbers are replaced by their squares. Again, prime numbers exclusively and the knight's path, etc., have been introduced and the squares, to some extent, studied.

Major Burnett presents in his booklet examples of some of these of the 15th and 16th orders. The last square that he gives is doubly magic of the order 8. They will be of service to those who are interested in the subject. There is an extensive literature. Ahrens deals with it in Chaps. xii. and xiii. of his second volume ("Mathematische Unterhaltungen und Spiele," Bands I., II. B. G. Teubner, Leipzig, 1918), and at the end of the volume gives no fewer than 182 references. W. R. Rouse Ball ("Mathematical Recreations") gives an interesting account and many references. Squares which possess row and column properties without any restriction upon the magnitudes of the cell numbers have also been studied. The theory of these is fairly complete since it has been shown that a syzygetic scheme indicating ground forms and syzygies can be constructed. The allied theory of the Latin Square of Euler has also been connected with the theory of differential operations.

It is much to be desired that some competent person should take up (say) the bibliography of Ahrens and give a good account of the present state of knowledge concerning the various natures of magic squares. This will take time and will involve a book of a fair size; but it ought to be undertaken, because the subject is no longer isolated from other parts of mathematics. Several substantial links have been forged during the last thirty years, and without question others are in prospect. P. A. M.

Bristol Geology and Geography: for the Use of School Teachers and Others. By Prof. Sidney H. Reynolds. Pp. 98. (Bristol and London: J. W. Arrowsmith, Ltd., 1924.) 2s. net.

BRISTOL is situated in a district rich in interest to the geologist and one which is well adapted to the study of physical geography. This little handbook has been produced by its author specially to meet the needs of teachers and students of geography and others whose interest in geology is only general. To this end the use of unfamiliar geological terms has been avoided, so far as possible, and, in addition, a glossary is provided.

The district described extends over a somewhat wider area than might be inferred from the title, and includes most parts of Gloucester and Somerset lying east of the Severn, up to within about 25 miles of Bristol, and takes in a little of Wiltshire. Prof. C. Lloyd Morgan's stimulating introduction to Reynolds' "Geological Excursion Handbook for the Bristol District," which outlines the historical and physical geology of the country surrounding Bristol, is reprinted in the book under notice.

Prof. Reynolds, after tabulating the geological strata and chief features of general interest in the district as a whole, proceeds to describe fourteen smaller physically or stratigraphically separable areas.

Detailed geological information, such as is given in the author's "Excursion Handbook," has, for the most part, been omitted, nor are there any references to previous literature. Prominence is given to the physical characteristics of each area, and the reader is assisted by a number of simple sketch maps and diagrams. A novel section of the book is that describing points of geological interest visible from a railway compartment to travellers in the vicinity of Bristol.

Prof. Reynolds' new handbook should serve its limited purpose very well, and may be recommended to visitors to Bristol, by whom it should be studied in conjunction with the geological model of the Bristol district on exhibition at the Museum there. "Bristol Geology and Geography," however, cannot, as its author points out, replace the "Excursion Handbook" as a guide in the field. V. A. E.

Flora of the Presidency of Madras. By J. S. Gamble. Part 6: *Scrophulariaceæ* to *Plantaginaceæ*. (Published under the authority of the Secretary of State for India in Council.) Pp. ii+963-1160. (London: Adlard and Son and West Newman, Ltd., 1924.) 10s. net.

THE feature of the present contribution to the Madras flora is undoubtedly the account of the Acanthaceæ, which occupies more than a third of the entire part. To most workers this family has been one of considerable perplexity, which has not been lessened by the use some recent authors have made in the classification of the genera of minute pollen characters. It is just this that will make the field-worker of S. India, for whom indeed the flora is chiefly written, grateful to Mr. Gamble for giving him a clear analysis of the family which does not necessitate the use of a compound microscope. The excellent keys of some of the larger genera are also improved by the addition of rather full specific details.

One of the most interesting genera treated of is Strobilanthes. So long ago as 1888 the author published in the *Indian Forester* a special study of the genus and an account of the curious periodic flowering of many of the species. Even in the condensed letterpress of this work, room has been found for brief details of this phenomenon. We learn, for example, that a gregarious shrub like *Strobilanthes Kunthianus* grows in such continuous masses on the grassy downs of the Nilgiris and other neighbouring hills that, when it all comes into flower together about every six years, it covers large tracts with blue. It is believed, indeed, by some that the name of that famous range was derived from this circumstance. Some of the other species have even a longer period of flowerless growth; *S. consanguineus*, for example, probably flowers only at intervals of twelve years.

Another family which shows evidence of a great deal of useful work is the Labiatæ, and near the beginning of this part is a valuable contribution to S. Indian botany in the treatment of the genus Utricularia.

La structure des cristaux: déterminée au moyen des rayons X. Par Prof. Ch. Mauguin. (Recueil des Conférences-Rapports de documentation sur la Physique. Vol. 6, 1re Série, Conférences 14, 15, 16. Édité par la Société *Journal de Physique*.) Pp. 281. (Paris: Les Presses Universitaires de France, 1924.) 20 francs.

THIS is an excellent introductory treatise describing the methods of X-ray crystal analysis and the results which have been obtained. A difficulty in the presentation of our new knowledge of crystal structure is due to the fact that we all dislike being asked to think in three dimensions. Prof. Mauguin has realised this, and provides numerous illustrations, many of them very ingenious, which force the reader to visualise the structures which are described. The book is well planned and deals thoroughly with the subject, while yet being concise. The student will find a short introduction to the geometry of space lattices which provides the necessary foundation for a study of crystal structure. The different methods of analysis are illustrated by examples of the more simple crystals. Three short chapters are devoted to atomic dimensions, the structure of the atom, and the interatomic forces, and a final chapter to a description of the principal types of crystals.

Prof. Mauguin has contented himself with a very brief reference to the more speculative aspects of the new science; a list of papers at the end of each chapter will aid the reader who wishes to pursue the subject further. The lucidity of the style makes the book easy to read, and it is a valuable addition to the literature on the subject.

Dairy Farming Projects. By Prof. Carl Edwin Ladd. (Macmillan Agricultural Project Series.) Pp. xix +327. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 7*s.* 6*d.* net.

THERE are many novel features in this volume which, although it applies to American conditions, still contains such an amount of information and suggestion that it cannot fail to be of great value to the teacher or student of dairy farming, and ought also to be of considerable interest to any farmer or owner of dairy stock. The whole field of dairy farming is covered: types of cattle; breeding, feeding, and management; methods of arranging and working the farm; business and financial aspects of dairy farming, even to suggestions for advertising stock and produce. There are also chapters on the diseases of dairy cattle, clean milk production, preservation of manure, etc., the whole being arranged under appropriate months from September to June.

It is perhaps doubtful whether the somewhat elaborate course of study which the author maps out could be worked in its entirety, but there is no question as to the educational value of what he proposes, and the ideas and methods could by slight adaptation be made to apply to any country.

The Vegetable Proteins. By Dr. T. B. Osborne. (Monographs on Biochemistry.) Second edition. Pp. xiii+154. (London: Longmans, Green and Co., 1924.) 9*s.* net.

A NEW edition of this well-known work has now appeared. While it contains all the essential material of the first edition, it has been largely rewritten and considerably amplified. The chapter on the proteins of green plants is brought up-to-date by details of Chibnall's work on leaf proteins. The new volume also contains a chapter by L. J. Henderson on the relation of proteins to acids and bases. This discusses the titration curves of vegetable proteins in an extremely lucid manner and presents an interesting addition to the literature of the subject. Frankel's work on the rate of hydrolysis of plant proteins is cited at length in the chapter on the products of hydrolysis, and recent work dealing with the subjects discussed in the original edition appears to be included throughout in sufficiently detailed manner.

The Philosophical Writings of Richard Burthogge. Edited with Introduction and Notes by Margaret W. Landes. Pp. xxiv+245. (Chicago and London: The Open Court Publishing Co., 1921.) 10*s.* net.

RICHARD BURTHOGGE (1638–1698) was an English medical practitioner who, with the exception of an early medical tract in Latin, "Disputatio de Lithiasi et Calculo," wrote entirely on philosophical and theological subjects. The chief of his works, "An Essay upon Reason and the Nature of Spirits" (1694), is interesting for the light it throws on the general state of philosophical opinion in England at the time when Locke's Essay appeared. The present work is not a reprint of any one of Burthogge's writings but a selection from several, accompanied by notes and collated facts concerning extant editions.

Le Principe constitutif de la Nature organique. Par Édouard Jung. (Bibliothèque de Philosophie Contemporaine.) Pp. 694. (Paris: Félix Alcan, 1923.) 30 francs net.

THIS large treatise seeks to bring under one comprehensive and constitutive principle the whole scheme of the conscious life from its basis in physiology and evolutionary biology to its manifestation in cognitive, moral, and æsthetic activity. It is mainly founded on the philosophy of Kant, and is an application of the logical categories and the Kantian method generally to the whole modern scientific biological problem.

Letters to the Editor.

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The Word "Scientist" or its Substitute.

I HAVE long thought that it is desirable, but perhaps not possible, to control the use of the words "science" and "art" and derivatives from them. The popular tendency is to make rubbish both of the original words and of the adjectives derived from them. Thus "science" is definitely used to describe the skill of the boxer, the text of Aristotle's writings, the highest mathematics, the twaddle of Mrs. Eddy, and the elements of chemistry.

In hopeless effort to define science it used (a hundred years ago) to be asserted that every art is based on a science and every science has its related art—a piece of glib and baseless assertion. It is Cicero, I believe, who says "*Scientiæ mentis artes*," the sciences are the arts of the mind, whatever "arts" may be. The French speak of "les Sciences," including therein all the "'ologies." In England we like to make-believe in an obscure essence or pervading entity which we call (when we are journalists) "Science" with a large S. Probably the historic and most luminous use of the word "science" is that in the plural, as in "l'Academie des Sciences." The British Association is for the advancement of *science*, not sciences, as it should be, whilst the Royal Society did not three hundred years ago use that word, but declared that it aimed at the promotion of "natural knowledge"—that is, knowledge of Nature, as distinguished from human tradition and Divine revelation.

We get some glimpse of a synonym for the word science when we find Cicero writing "*Physiologia naturæ ratio*," which must be translated "Physiology, the ratio (or 'reasoned story') of Nature." All the "'ologies" or branches of science are ratios or reasoned stories of those sciences. But I can find no word which will serve to distinguish one who deals with many branches of science or to name a body of men dealing with many distinct sciences. It is easy to name those who take up this or that science, as geologist, phytologist, zoologist, chemiologist (chemist), electrologist (electrician), etc. But we soon get into a muddle, even here, since words derived from φύσις have been insanely perverted in meaning during the past three hundred years—for example, *physic* and *physics*, *physicien* and *physician*, as well as *physiology* (this last to mean *not* "natural history," as it should, but the study of the activities of the organs of animals and plants).

I hope NATURE will continue to refuse to use the word "scientist." Its formation can be defended, it is true, as parallel to that of "artist." But the example of the word "artist" gives us no encouragement, for it is the most vague and ill-used word in our language. All sorts of mysterious qualities are claimed for "the artist," and any impostor can defend his claim to be "an artist," and to worship art with a big A. We shall have others saying they "stand for" science with a big S and calling each other "Scientist." The eminent scientist Barney Bunkum is already flourishing in the United States and in English newspapers. I think *we* must be content to be anatomists, zoologists, geologists, electricians, engineers, mathematicians, naturalists (that last is a term I like and wish to use). We cannot find a name to join all the followers of different branches of science, but I think that "rationalist" rightly designates those who, in their inquiries into the unknown in whatever field, strictly follow the scientific method.

It is well to remember in this connexion what Clifford wrote in one of his essays: "There are no scientific subjects. The subject of science is the human universe—that is to say, everything that is, or has been, or may be related to man."

What then *can* we mean by calling a man a scientist? We cannot mean that he studies or pursues any *special* subject. Every subject can be the subject of science. "Science" and "scientific," of course, have reference to the method and habit of mind. Our "man of science" is a man who makes use of and cultivates a special habit of mind or method which is known as the scientific method or experimental method. Assuredly this is *not* what the journalist means when he calls a person "an eminent scientist."

In old times the word "philosopher" was quite properly used for those we now call men of science: they were called "philosophers" or sometimes "natural philosophers," but custom—the most absurd jade we tolerate—actually nowadays restricts "philosophy" to speculations about metaphysics. Hamlet's "philosophy" was wider and all-embracing. The founders of the Royal Society called themselves "Philosophers." I am afraid that word will not do, to-day, for what is wanted; and I feel pretty sure there is not one which will. I should call myself alternatively a philosopher, a natural philosopher, a naturalist, or a rationalist. Rationalist is really the best designation. All men of science are rationalists, but many shrink with fear from the word, since they have been told that the devil himself is a rationalist. It is, however, a just and honourable title. On the other hand, "scientist" has acquired—perhaps unjustly—the significance of a charlatan's device.

E. RAY LANKESTER.

44 Oakley Street,
Chelsea, S.W.3.

IN my little book on "Notes on the Composition of Scientific Papers" I have defended the use of "scientist": it is quite a normal word, such as artist, economist, etc. Against it is the dislike of all new words or spellings; they are contrary to our habits. But there is more than this: in England (especially as compared with Germany or Scotland) there has been a certain prejudice against science as a *profession*. Many of our great men (*e.g.* Darwin, Rayleigh, Clerk Maxwell, etc.) have been great amateurs; and the generations bred upon letters only (*e.g.* Swift) have regarded science as too arid for exclusive culture. The amateur is saved from being narrow or inhuman. So there has been an unconscious antipathy to science as a calling or profession. But I am speaking of our prejudices—remnants of the past—which now are cobwebs, and no more. I should accept the word were I in your place. NATURE has set a good example in another very important—far more important—linguistic matter, namely, the use of "*fact*" as distinct from opinion, or inference, or axiom, or principle, or truth, etc., in the sense of general statement founded upon (assumed) facts. We collect our facts, and upon them are built fallible conclusions or laws, which not a few contributors call also "*facts*." We must keep the word fact for the several events, and call our inferences opinions, conjectures, hypotheses, etc., and ultimately, when relatively certain, theories; theory is our highest scientific category. To mistake inferences or axioms for facts has been a curse of science.

CLIFFORD ALLBUTT.

St. Radegund's, Cambridge.

THE "Oxford Dictionary" defines *scientist* simply as "A man of science." It defines *man of science* (*s.v.* Science, 6) as: *a* (a sense ruled out as obsolete); *b*, "In modern use, a man who has expert knowledge of some branch of science (usually, of physical or natural science), and devotes himself to its investigation." All this with no suggestion whatever that the usage is blameworthy or questionable, or that there is any other modern acceptation.

Accordingly, in the "Pocket Oxford Dictionary" published this year, the only definition of *scientist* given is "(esp.) person learned in one or more of the natural sciences," in which "(esp.)" merely indicates that the limitation to the natural sciences is, though usual, not so far obligatory that, *e.g.*, a pure mathematician might not, exceptionally, be called a scientist.

My opinion is, then, that to refuse the word the now prevalent and extremely convenient sense that you mention, "a worker in the field of physical or biological science," is antiquated pedantry. I may add that nothing is gained by the substitution of *man of science*, so far as meaning is concerned; for any undesirable vagueness that may attach to *scientist* comes to it only as a consequence of *science's* having also more than one sense. But I suspect that those who really have an instinctive (as opposed to a merely imitative) aversion to this use of *scientist* are influenced not by doubts of its meaning, but by dislike of its (and many other -ist words') slightly abnormal formation; but that is not the point raised in your question. H. W. FOWLER.

Moulin de Haut, Guernsey.

So long ago as 1840, according to the "Oxford Dictionary," Dr. Whewell, eminent as man of letters as well as man of science, wrote: "We need very much a name to describe a cultivator of science in general. I should incline to call him a Scientist." I do not think the objections to the word on merely literary or linguistic grounds can be maintained. It is a hybrid, but the language is full of hybrids: moreover, it may well be argued that *-ist* is naturalised as an English termination.

There is, however, another sort of objection which has to be weighed. Like other words in *-ist*, it has a professional air, as if the man who so described himself were claiming an *ex cathedra* authority for his utterances. Hence its use is not always complimentary. We see this in its derivatives "scientism" and "scientistic." Similarly, when I have been introduced to a public meeting as an "educationist" or "educationalist," I have wished to be saved from my friends: I would rather be called a schoolmaster. My conclusion is that the term scientist is too convenient to be wholly rejected, but that writers would do well to remember its less complimentary use as a label, and not resort to it too frequently.

J. H. FOWLER.

16 Canynge Square, Clifton, Bristol.

THE word "scientist" is, in itself, neither better nor worse than dentist, oculist, socialist, or violinist. It would be pedantic, at the present day, to object to it merely on the ground that it begins in one language and ends in another. If it were a new word, introduced for the sake of brevity and convenience by some respectable writer, I should have little objection to it; I should be reluctant to use it myself, but I should not dream of objecting to its use by others.

It seems to me, however, that the word has already got a sort of taint about it, very much as the word "sophist" did in Greek. It is often used in an equivocal, or even disparaging, sense, by people who have no great respect either for science or the "scientist." Most men of science would surely rather be called so than be dubbed scientist. The widely used term "Christian Scientist" has helped to make matters worse; what that phrase means I do not know, but if I did know I am sure I should not like it any the better.

On the whole, I take it that the word scientist has been in low company, and I should be very slow to introduce it into better.

D'ARCY W. THOMPSON.

St. Andrews.

REGARDING the inquiry contained in your letter, I would say that the word "scientist" has fully established itself in the written and spoken language of scientific workers as well as of non-scientific persons. It is, of course, when one stays to examine it, a hybrid, but like that other hybrid, the mule, it does useful work. After all, there are numbers of hybrid words in our language also doing useful work, and one does not now trouble to look them in the mouth. For example, take the Latin stems with the Greek termination *-ist*. The psychologists do not blush to use the word "animist"; they even say "behaviourist." In my opinion, "scientist" is a gentle-born word alongside of "behaviourist," which may well have besmirched the pages of NATURE.

W. J. SEDGEFIELD.

The University, Manchester.

I HAVE submitted your inquiry to my son, who is a literary critic. He sees no objection to "scientist," and is rather surprised that it has not been adopted before. He thinks it as well-formed as "artist." He does not much like words ending in "ist," but concludes that they cannot be avoided.

For myself, I dislike the word, but cannot give a clear reason for the dislike—unless it be that the preposterous term "Christian" prefixed to it has given it an alien significance. On the whole, I feel that the public has forced the word upon us, and that we must succumb. OLIVER LODGE.

Normanton House,
Lake, Salisbury.

PERSONALLY, I should say "man of science" rather than "scientist"; but I do not think one can deny to the word scientist its legitimate place in English. It is recorded in the "Oxford Dictionary," together, I admit, with a good many words which a man does not use if he can help it. But the place of "scientist" in the English vocabulary must have been fairly safe since Whewell wrote in 1840, "We need very much a name to describe a cultivator of science in general. I should incline to call him a Scientist."

R. W. CHAMBERS.

University College,
Gower Street, W.C.

IN spite of the objections which have been raised to the use of the word "scientist," it may with advantage be used in place of "scientific worker" or "man of science." Whewell seems to have coined the word to describe "a cultivator of science in general." On the whole, there is much to be said in favour of it. It should not, however, in my opinion, be limited to a worker in the field of physical or biological science. ISRAEL GOLLANCZ.

King's College, London.

My intense dislike of the word "scientist" is due to the fact that it debases the currency. The word is not applied to a man to indicate respect for his scientific or philosophical attainments, but to indicate a certain disdainful attitude towards the truth claims of æsthetic, moral, and religious values. The distinction so often expressed between philosophers and scientists is a false one when it implies (and it is meant to imply) that philosophers are uninterested in or indifferent to the positive results of science.

H. WILDON CARR.

107 Church Street,
Chelsea, S.W.3.

The Biology of Verse.

IN NATURE for October 11, 1924, p. 534, I have reported the results of the only registrations of verse ever made and analysed. They show that verse is a current of speech energy of varying amount so adjusted as to come in more or less regular waves. When the centroids of these waves are calculated, they are found to occur at approximately equal periods.

The next problem is that of the source of this current of energy. The replies of many living poets to a question-paper agree without exception with all the statements I have been able to find from the poets of the past: they have no ideas whatever on the subject. They all assert, moreover, that the verse-form comes to them ready-made along with the poetic content. This poetic content, they all declare, is forced upon them by some inner power. The source of verse, therefore, must be sought in the source of poetry.

The poets all agree that the source of their poetry lies entirely outside of their consciousness. In psychological terms it is a product of the unconscious. In physiological terms it is a product of bodily processes that result in producing poetical feeling and ideas in consciousness. In either sense it is a biological phenomenon of which the ultimate explanation must be in biological terms.

On the psychological side there are the statements of famous poets of the past. Many say that they write because they must (Pope, Goethe, Schiller, Grillparzer, Hebbel, Brentano, and so on). One of them says that whenever a new poetical idea struck him he had to write it down even at the cost of his life. They often write in over-excited or half-conscious conditions (Goethe, etc.). They write to relieve themselves from mental strain or trouble (*e.g.* Byron). They write out their own inner selves (Byron, Goethe, Schiller, Hebbel). They write because they feel themselves mentally ill (Grillparzer, Heine). They write because they feel themselves to be criminals in need of confession (Hebbel, Ibsen). A poet is a lunatic (Shakespeare). Poetry flows from the poet like gum from a tree (Shakespeare). The statements that I have collected from living poets are along the same lines.

Further psychological information is furnished by the work of Freud and his gifted disciple, Otto Rank. Poetry is the result of an inner conflict. On one side is the fundamental part of the Unconscious, the "It," with its one impulse to have its own inflexible way and to obtain peace; on the other side is the Self, or the "I," with the wish to live, love, and enjoy by adapting itself to the environment. Out of the struggle there is engendered the Conscience, a kind of council of the League of Nations that sits in judgment over the self. Again, like the League of Nations, it is controlled by the stronger powers of the "It" and has the one function of condemning the weaker "I." At the instigation of the "It," Conscience takes every opportunity of declaring the "I" to be a criminal worthy only of annihilation and death. It is kept from doing so only by the power of the Self to resist it. The details of this conflict must be sought in the works of Otto Rank.

The result of the conflict depends on the amount of fundamental energy, or kinetic drive, at the disposal of the Self. When this becomes small, as in misfortune, weakness, illness, or grief, the Self can no longer resist the efforts of "It" to get Conscience to pass a condemnation of the Self to some degree of death varying from withdrawal from social life to suicide. With more fundamental energy the Self struggles with varying success but never gets real control; this produces the condition of the neurasthenic failure. With a larger amount of fundamental energy the result depends on what compromise can be effected. Sometimes the Self compromises with the "It" by carrying out some of its anti-social demands; this produces the criminal. Sometimes the Self can win only by denying the truths of the environment; this produces the lunatic. Sometimes the Self can escape by affording the "It" a means of letting off its force in a way that partially lightens the pressure but yet does not bring the Self into conflict with the environment. This produces the class to which the poet belongs.

Poetry is thus the expression of the impulses of the "It" in a form acceptable to the environment. These impulses are familiar to Freudian analysts. Some of them have been exhaustively treated by Otto Rank. A complete general treatment of the poetic conflict has not yet been made.

It is my own belief, however, that this conflict can be reduced to biological terms that can even be measured. In NATURE for March 15, 1924, p. 386, I have shown that records of speech show the presence of three biological forces; the impulse to conform to the speech of the environment, the hindrance to successful conformity, and the impulse to correct the resulting defect. The three forces correspond quite well to the Freudian concept of the Self, the "It," and Conscience. In many speech records—both normal and pathological—the prevalence of one or another of these forces can be plainly seen and measured. It is a commonplace of my laboratory to use the size of the probable error in making speech sounds as a measure of the successful adaptation of the speaker to his social environment. A large probable error indicates either an increase of the inner hindrance to adaptation or a decrease in the impulse to correction—or in Freudian terms either an increase in the power of the "It," or a decrease in the force of the Self or a decrease in the power of Conscience. Quite characteristic is the fact that a very large probable error is diagnostic of general paralysis, a disease the earliest characteristic of which is a decay of the social sense, that is, of Conscience.

Whether the result of this conflict depends on metabolism or the presence or removal of toxins in the blood or on the hormone balance, biochemistry must determine. It is my belief that a physiological explanation quite parallel to the psychological one can be found.

In any case poetry is the product of a compromise among biological forces whereby the social force is strong enough to affect the adjustment by allowing the anti-social force some degree of expression.

The source of the verse form itself is now clear. Rhythmic speech is the primitive form of language. The linguist Prof. Jespersen of Copenhagen agrees with the poet that

> Thus Nature drove; warbling rose
> Man's voice in verse before he spoke in prose.

OEHLENSCHLÄGER.

The natural speech expression of the more primitive savage Unconscious is in verse form. That is why, as so many poets report, their poems come to them suddenly in completely finished form (Goethe, Grillparzer, Hebbel, Brentano, Fontane, Goncourt, Flaubert, and many living poets). The source of the verse form thus lies, like the source of poetry, in a partial yielding of the Self to the demands of the Unconscious for expression.

E. W. SCRIPTURE.

University of Vienna.

Experiments on Sex in Mushrooms and Toadstools.

MISS MOUNCE,[1] working under my direction, found that *Coprinus sterquilinus*, *C. stercorarius* (a sclerotium-producing species), and *C. narcoticus* are all homothallic. All the spores in each of these species are sexually of one kind, and each spore gives rise to a mycelium which becomes diploid and fruits perfectly without fusion with any other mycelium.

Hans Kniep[2] has shown that in *Schizophyllum commune* and *Aleurodiscus polygonius*, segregation in the basidium results in the production of four sexually different haploid genotypes, so that the spores sexually are of four different kinds. Normally one kind can react with only one of the others. Two Mendelian pairs of factors are involved. The diploid fusion nucleus in the basidium bears both pairs of factors and may be represented as (AaBb). The haploid nucleus of each of the four spores bears only one of each pair of factors, so that sexually the four kinds of spores may be represented as (AB), (Ab), (aB), and (ab).

W. F. Hanna,[3] working in my laboratory upon *Coprinus lagopus*, has confirmed Kniep's results. His experiments, which have involved some 1500 matings, clearly demonstrate that, here again, we have a species which bears spores which sexually are of four different kinds: (AB), (Ab), (aB), and (ab).

There has just come into my hands a paper by Vandendries,[4] in which he records experiments which prove that *Coprinus radians* is bisexual, *i.e.* that this fungus produces spores which fall into two sexually opposite groups, and not into four groups as found by Kniep for *Schizophyllum commune* and *Aleurodiscus polygonius* and by Hanna for *Coprinus lagopus*.

Miss Dorothy Newton,[5] who has been studying the problem of sex in my laboratory for upwards of a year, has obtained results with *Coprinus Rostrupianus* which are exactly similar to those Vandendries obtained with *C. radians*; for, as a result of upwards of 400 matings, she has found that in *C. Rostrupianus* the spores fall into only two groups which are sexually opposite.

In *Aleurodiscus polygonius*, under certain abnormal moisture conditions, the four spores of each basidium are shot away together in a single mass. Kniep[6] noted this fact and took advantage of it to analyse the sexual reactions of the four spores on each of thirty-five basidia. He found that each basidium bore two kinds of spores, two of one sex and two of another, and that there were two kinds of basidia, so that the two pairs of spores of one group of basidia were different sexually to the two pairs of spores of the other group of basidia. The four spores of one group may be represented as (AB), (AB), (ab) and (ab), and the four spores of the other group as (Ab), (Ab), (aB) and (aB).

Kniep's method of obtaining the four spores of a single basidium and separating them by shaking them apart in agar is applicable, so far as is at present known, only to *Aleurodiscus polygonius*; and Vandendries was unable to analyse the sexual reactions of the four spores of a single basidium of his *Coprinus radians*.

A method for removing the four spores of a single basidium and sowing them separately has been devised in my laboratory, and it has the advantage over the method used by Kniep in that it is not dependent on an abnormality but is generally applicable to normal fruit-bodies of Coprini and other Hymenomycetes.[7] The method is as follows. A gill is placed on a slide and a cover-glass is lowered down upon it and pressed gently against the hymenium. The cover-glass is then raised, inverted, and examined under the microscope. The four spores of each of a number of basidia are then seen to be attached by their apices to the cover-glass, so as to form tetrads resembling those which may be observed on isolated basidia when one looks down on a gill from above with the microscope. Using the dry-needle method, described by Hanna,[8] it is then not difficult to remove the other spores around a perfect tetrad and afterwards to pick up the four spores of the tetrad one by one and sow them individually in hanging drops of a culture medium.

By employing the methods just described, both Hanna and Miss Newton have successfully analysed the sexual reactions of the four spores of a considerable number of individual basidia. In Hanna's quadrisexual species, *Coprinus lagopus*, some of the basidia were found to bear spores of two kinds only, a pair of one sex and a pair of another and opposite sex, while other basidia were found to bear spores of all four kinds: (AB), (Ab), (aB), and (ab). The occurrence of four different kinds of spores on a single basidium proves that the reduction process in the basidium takes place with the second division of the nucleus, and not with the first as found by Kniep in the case of *Aleurodiscus polygonius*. In Miss Newton's bi-sexual species, *Coprinus Rostrupianus*, all the basidia have been found to be exactly alike, for they all bear only two kinds of spores, two of one sex and two of the other and opposite sex.

A. H. REGINALD BULLER.

The University of Manitoba,
November 13.

[1] Irene Mounce: (1) "Homothallism and the production of fruit-bodies by monosporous mycelia in the genus Coprinus," Trans. Brit. Mycolog. Soc., viii., 1921, pp. 198-217. Also (2) "Homothallism and heterothallism in the genus Coprinus," *ibid.* 1922, pp. 256-269. An account of the experiments made with *Coprinus narcoticus* has not yet been published.

[2] Hans Kniep: (1) "Über morphologische und physiologische Geschlechtsdifferenzierung," *Verhandl. der physikal.-med. Gesellschaft zu Würzburg*, xlvi., 1919; (2) "Über Geschlechtsbestimmung und Reduktionsteilung," *ibid.* xlvii., 1922; (3) "Über erbliche Änderungen von Geschlechtsfactoren bei Pilzen," *Zeitsch. Indukt. Abstamm. u. Vererb.*, xxx., 1923.

[3] W. F. Hanna, "The Problem of Sex in *Coprinus lagopus*." To appear shortly in the *Annals of Botany*.

[4] R. Vandendries, "Contribution nouvelle à l'étude de la sexualité des Basidiomycètes," *La Cellule*, xxxv., 1924.

[5] D. Newton, paper shortly to be sent to the press.

[6] Hans Kniep, "Über Geschlechtsbestimmung und Reduktionsteilung," *Verhand. physikal.-med. Gesellschaft zu Würzburg*, xlvii., 1922, pp. 1-29.

[7] The method is described in Hanna's paper on *Coprinus lagopus*. It was devised and perfected by Miss Dorothy Newton, W. F. Hanna, and the writer, working conjointly.

[8] W. F. Hanna, "The Dry-Needle method of making monosporous cultures of Hymenomycetes and other fungi," *Annals of Botany*, xxxviii., October 1924.

Negative and Doubly Charged Positive Ions in Argon.

IN letters to NATURE (June 16, 1923, and July 26, 1924), and elsewhere (Proc. Roy. Soc. A, vols. 102, 104, 105), Dr. H. D. Smyth has described investigations he has made of the ionisation of several diatomic gases. By using positive ray analysis he was able to correlate different ionisation potentials with the production of ions of different ratio of mass to charge. I have now used the same apparatus to study the ionisation of argon, chiefly to explain, if possible, the "blue" spectrum of this element.

From a preliminary analysis of results I found that singly charged, positive, atomic argon ions were first produced in detectable numbers when an accelerating potential of about 17 volts (uncorrected) was applied to electrons striking the atoms. I do not consider that the accuracy of the determination is sufficient to distinguish between the varying results of other observers.

Doubly charged, positive atomic ions were not produced at all until an accelerating potential of more than about 45 volts was applied. For the most part these must have been produced by single impacts as the pressures and thermionic currents used were so small as to make successive impacts very improbable. This result is contrary to the assumption that the critical potential of about 34 volts at which the first part of the blue spectrum appears (Horton and Davies, Proc. Roy. Soc. A, 102, p. 131 (1922), and Déjardin, *Ann. de Phys.*, 10th Series, v. ii., p. 241 (1924)) corresponds to the production of doubly charged ions. Therefore this portion of the blue spectrum cannot be the entire first enhanced spectrum of argon. It may be due to excitation of the singly ionised atom, but the detailed application of this hypothesis meets difficulties which are too complicated to discuss here.

I also found that large quantities of negative ions could be produced. These apparently originated in a region of the tube where impacting electrons had just sufficient energy to excite the atoms. It therefore appears that in argon it is a necessary and sufficient condition for the capture of an electron that the atom first be in an excited state.

A full report of this work is to be published shortly.

HENRY A. BARTON.

Palmer Physical Laboratory,
Princeton University,
November 3.

Flow of Sap in Trees.

IN recent discussions on the upward movement of sap in trees, I have seen no mention of an interesting observation of Charles Darwin to be found in his "Voyage of the Beagle" (p. 258, John Murray, 1912 edition). He was exploring the Campana or Bell Mountain about 26 miles from Valparaiso, and he writes as follows, for the quotation is worthy to be reprinted in full :

"In a few places there were palms, and I was surprised to see one at an elevation of at least 4500 feet. These palms are, for their family, ugly trees. Their stem is very large, and of a curious form, being thicker in the middle than at the base or top. They are excessively numerous in some parts of Chile, and valuable on account of a sort of treacle made from the sap. On one estate near Petorca they tried to count them, but failed, after having numbered several hundred thousand. Every year in the early spring, in August, very many are cut down, and when the trunk is lying on the ground the crown of leaves is lopped off. The sap then immediately begins to flow from the upper end, and continues so doing for some months ; it is, however, necessary that a thin slice should be shaved off from that end every morning, so as to expose a fresh surface. A good tree will give ninety gallons, and all this must have been contained in the vessels of the apparently dry trunk. It is said that the sap flows much more quickly on those days when the sun is powerful ; and likewise, that it is absolutely necessary to take care, in cutting down the tree, that it should fall with its head upwards on the side of the hill ; for if it falls down the slope, scarcely any sap will flow ; although in that case one would have thought that the action would have been aided, instead of checked, by the force of gravity. The sap is concentrated by boiling, and is then called treacle, which it very much resembles in taste."

The effect of the sun and the great quantity of sap from a felled tree are both noteworthy, but the effect, or rather inhibition, due to gravitation, adds mystery to an obscure subject. A friend has proposed to test this gravitational effect with two young felled sugar maples next spring.

A. S. EVE.

McGill University, Montreal,
November 1.

The Colour of Sulphur Suspensions.

IN the review of Ostwald's "Licht und Farbe in Kolloiden" which appeared in NATURE of November 8, p. 672, the reviewer alludes to the investigations of Keen and Porter on "sulphur suspensions containing particles *large compared with wave-lengths* and indigo in *transmitted light.*" He adds, "No theory of this phenomenon is available so far ; until one is found there will be a distinct gap in the optics of disperse systems."

A theory of the effect observed by Keen and Porter was given by Prof. C. V. Raman and Mr. B. Ray in 1922 ("On the Transmission Colours of Sulphur Suspensions," Proc. Roy. Soc. A, vol. c., pp. 102-109), the explanation offered being that the colour of the transmitted light is due to interference between the primary wave and the light scattered by the particles in the direction of the primary wave. Results were given of calculations based on Rayleigh's theory of the scattering of light by a transparent sphere.

Raman and Ray repeated Keen and Porter's experiments and found that the diameter of the sulphur particles when the indigo colour first appeared was considerably less than that quoted by Keen and Porter, but that the amended value agreed satisfactorily with the theory. The theory appears to be adequate, although the computation of numerical results is extremely tedious. A more complete comparison of theoretical with experimental results than has yet been published is desirable.

E. T. PARIS.

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Woolwich Common, S.E.

Absorption Spectra of Mixed Metallic Vapours.

DURING work on the absorption spectra of mixtures of metallic vapours, I have obtained band spectra peculiar to mixtures of magnesium and alkali metals, and also to mixtures of calcium and alkali metals. A sodium-potassium band spectrum has already been described (Proc. Roy. Soc., 1924). The existence of such band spectra is of interest, as it points to the presence of molecules of volatile alloys of these metals in the mixed vapours.

I have incidentally observed that lines of the series $1S - md$ are developed in the absorption spectra of rubidium and cæsium vapours. As has been remarked by Datta, who observed the corresponding absorption in potassium, the development of such series in the absence of an electric field is a contravention of the selection principle, since it involves a change of two in the azimuthal quantum number.

I have, further, been unable to trace any previous observation of the cæsium series $1S - md$, either in emission or absorption, and wave-length measurements, as well as experiments upon the conditions necessary for its appearance, are at present in progress.

S. BARRATT.

University College, Gower Street, W.C.1,
November 12.

The Ages and Masses of the Stars.

By J. H. JEANS, Sec. R.S.

AS is well-known, a rapidly moving electron has a greater mass than a stationary one; more force is required to deflect it from its path or to produce a specified acceleration. The theory of relativity shows that this is not an isolated phenomenon, but an example of a universal principle. Every natural system, on acquiring additional energy E increases its mass by E/C^2, and a loss of energy causes a corresponding loss of mass.[1] For example the sun, losing energy by radiation at the rate of $3{\cdot}8 \times 10^{33}$ ergs per second, must be losing mass at the rate of $4{\cdot}2 \times 10^{12}$ grammes (about four million tons) a second.

Changes of energy and changes of mass are, then, the same thing: it is immaterial whether we specify the change in terms of energy or of mass. It is a somewhat different question whether absolute mass can be specified as absolute energy or vice versa. For example, setting an electron in motion with a velocity $0{\cdot}866C$ doubles its mass, but in what sense does it double its energy? If m was the mass of the electron when at rest, the addition m to its mass has represented an addition mC^2 of kinetic energy, but did the original mass m also denote energy mC^2?

Clearly an electron at rest must be thought of as having some energy, for it consists of electric charges which have been brought very close to one another in opposition to their mutual repulsions. If an electron is regarded as a negatively charged sphere, its electrostatic energy is $\frac{3}{4}mC^2$. To satisfy the conservation of energy when the electron is in motion, there must be further energy $\frac{1}{4}mC^2$ of unknown type,[2] making energy mC^2 in all. Presumably the whole of this would be set free if the electron could be persuaded to explode and scatter to infinity.

The energy mC^2 just discussed may be called "sub-electronic" energy, any further energy which electrons may have in virtue of their motion or positions in space being "super-electronic" energy. The two energies become equal when an electron moves with a velocity $0{\cdot}866C$, corresponding to a temperature of 4,000,000,000° Centigrade; for an atom the corresponding temperature is thousands of times higher. In all actual systems, then, the super-electronic energy is insignificant in comparison with the sub-electronic. In the sun the ratio of the two kinds of energies is probably at most of the order of one to a million, and the same is of course true of the two kinds of mass. Of the sun's total mass of 2×10^{33} grammes, not more than about 2×10^{27} grammes can be "super-electronic."

The sun, as we have seen, is radiating mass away at about four million tons per second. The usual estimates of the sun's age have all been based on the supposition that the only mass available for radiation is the "super-electronic" mass. The estimates reached in this way, about twenty million years, have been too short to satisfy either astronomers or geologists. Some years ago I suggested that the source of stellar radiation was to be found in an actual destruction of matter in a star's interior, the mechanism probably being that positive and negative electric charges fell together and annihilated one another. The essential novelty in this suggestion was that it made the enormous "sub-electronic" mass of a star available for radiation, in addition to the comparatively puny "super-electronic" mass; thus it immediately extended our estimate of the sun's life by a factor of the order of a million. Whatever else may be thought of this suggestion, it must be admitted that it solves, with a comfortable margin to spare, the age-long problem of the source of the energy of stellar radiation.

Nothing in the suggestion appears to conflict with modern atomic physics. According to classical electrodynamics, the mutual destructiveness of positive and negative charges was such that all the matter of the universe ought long ago to have melted away in a blaze of glory. The quantum-theory has introduced restrictive forces which, in some way unknown to us, keep positive and negative charges apart, but these forces are not unfailing in their action. At times the electron in the hydrogen atom eludes them and drops down from orbit 3 to orbit 2, at times it drops farther from orbit 2 to orbit 1; let it sometimes also drop from orbit 1 to orbit 0, and what we have been imagining becomes an accomplished fact.

In the form in which we have so far put it, the whole question looks somewhat speculative. It takes on an entirely new complexion in the light of the definite results recently obtained by Eddington (cf. NATURE, May 31, 1924). Both as a matter of theory and of observation, Eddington finds that a star's luminosity is a function, approximately, of its mass alone. All the stars that are about as massive as Sirius have about the same luminosity as Sirius, stars as massive as our sun are about as luminous as our sun, and so on. At present Sirius has 2·5 times the mass of our sun, and 36 times the luminosity. Not having an unlimited store of energy it cannot go on radiating at its present rate for ever; its luminosity must eventually decrease, and some day this will only be equal to that of our present sun. When that day comes, Sirius will be only about as massive as our present sun, so that between now and then it must lose 60 per cent. of its present mass. This is enormously more than the total "super-electronic" mass of Sirius, so that we conclude that the main part of its loss of mass will of necessity be "sub-electronic." Further, we know of no normal process by which mass can escape except by radiation, whence we conclude that the diminution of mass is the equivalent of the energy radiated away.

If this be conceded, Eddington's relation between luminosity and mass fixes quite definitely the rate at which stars change both their luminosity and mass. For example, the sun with a mass of 2×10^{33} grammes, is radiating away $4{\cdot}2 \times 10^{12}$ grammes a second. Thus, after 1,500,000 millions of years its mass will be reduced by 10 per cent., so that from Eddington's table, its luminosity will be reduced by about 30 per cent. In the same way we find that the interval on the evolutionary ladder between Sirius and our sun is approximately $6{\cdot}4 \times 10^{12}$ years. Between a giant sun of ten

[1] Here and throughout C denotes the velocity of light, 3×10^{10} cm. a second.

[2] Jeans, "Electricity and Magnetism," 4th edition, § 667.

times the mass of our sun and our sun, the interval is $7{\cdot}5 \times 10^{12}$ years. These two figures do not differ greatly, for a star squanders its mass at a great rate during its highly luminous giant state; it is the last part of the journey that takes the time. Both figures are of course enormously large in comparison with any estimates heretofore made on the ages of the stars.

If nothing unexpected intervenes in the next $6{\cdot}4 \times 10^{12}$ years—and it must be admitted that there is time enough for the unforeseen to occur—Sirius will at the end of that period be similar to our present sun. We cannot, however, assert that $6{\cdot}4 \times 10^{12}$ years ago our sun was in the state of the present Sirius. The old-fashioned astronomer believes that the whole universe was created only some 10^9 or 10^{10} years ago, and until the contrary is proved he has a right to his opinion.

The geologist insists that life on our earth must have existed for millions of years because fossil bones occur under deposits which, he estimates, must have taken millions of years to accumulate. A similar method of reasoning is available to the cosmogonist, who has the advantage over the geologist that he can calculate, instead of estimating, his periods of time.

All calculations in cosmogony have hitherto been made on the supposition that stellar masses remained constant. The conception of diminishing masses brings new features into almost every problem of cosmogony. For example, the orbit of a particle about a gravitating mass is no longer an endlessly repeated ellipse; it is an ellipse of ever-increasing size, the major axis of which varies inversely as the mass of the attracting body. After 1,500,000 millions of years, when our sun will only have nine-tenths of its present mass, the radius of the earth's orbit will be ten-ninths of its present size and the year will have lengthened to 451 days. The whole universe of stars is expanding for the same reason and in the same way as the solar system. When, if ever, in the past the average star had four times its present mass, the stars must have been 64 times as closely packed as now, and stars must have interfered with their neighbours 64 times as much as they now do. When due allowance has been made for this, it is found that features are shown by the stars which could be produced by the influence of neighbouring stars in periods just about equal to those we have had under consideration, say six or seven millions of millions of years. These features are the fossil bones of cosmogony.

Foremost among such features must be placed the orbits of binary stars. A newly formed binary star has generally a period of a few hours and an almost circular orbit of radius of the order 5×10^{11} cm. Old binaries show much longer periods, orbits which are frequently highly eccentric and of radius much greater than those of new stars. Statistically, the orbits tend towards conformity with what may be called the "equipartition law"—the law which would be obeyed exactly if the binaries were pushed and pulled about by their neighbours for an unlimited time. Calculation shows that the observed partial conformity to this law indicates a knocking about for a period of the order of that just mentioned, say six million million years.

The same period is indicated by the velocities of the stars in space. Statistically, the most massive stars have the lowest velocities, and there is a pronounced tendency to obey an "equipartition law" under which the velocity varies inversely as the square-root of the mass. This would be obeyed perfectly if the stars had influenced one another for ever; the partial extent to which it is obeyed again indicates a period of the order of six million million years.

A somewhat less convincing "fossil-bone" is provided by a study of the ratios of the masses of the two components of binary stars. As a binary gets older, its components become more equal in mass. According to Aitken,[3] 20 spectroscopic binaries of early type (B to B8) show an average mass-ratio 0·70, while 7 of late type (F to G) show an average mass ratio of 0·89. Calculation shows that to pass from a mass-ratio 0·70 to one of 0·89 would require a period of 4·5 million million years. The numerical result is entirely satisfactory, but it must be admitted that it is based on scanty material.

Finally, it may be remarked that the extension of the time scale which is now proposed increases enormously the chance of solar systems being formed by tidal action. With a time scale of 10^9 years, we had to think of systems of planets such as our own as being of necessity extremely rare. With the longer time-scale and the recognition that our system of stars must have been more closely packed in the past than now, we can think of planetary systems as being, if not quite the normal accompaniment of a sun, at least fairly freely distributed in space.

[3] "The Binary Stars," pp. 206, 207.

The Ages of Peat Deposits.

By Dr. W. H. PEARSALL.

RECENT work on the Yorkshire peat has raised some very interesting problems as to the ages of various types of peat deposit in the British Isles. One of the striking features of the Pennine peat is the normal absence of any marked differences in composition, such, for example, as the definite forest layers observed in the Scotch deposits by Prof. Lewis. Typical Pennine peat is usually composed entirely of cotton-grass remains, though here and there the remains of heather or birch point to local desiccation, which can usually be traced to drainage. In the Ingleborough district, Messrs. Cheetham and Burrell find the basal vegetation to differ very slightly from that of the main peat, though rushes are often present. Birch scrub with local pine and oak is also very widely distributed up to 1900 ft. The presence of oak is suggestive, since this tree is not known from deposits older than Neolithic, either in England or Scandinavia.

Mr. J. Holmes first pointed out that neolithic flints occurred about the base of the peat, and now further information is accumulating, largely through the efforts of Mr. F. Buckley and Dr. T. W. Woodhead. They

have found among the trees at the base of the peat, a horn of *Bos primigenius* and a triangular arrow-head of the Neolithic Dolmen period. At a somewhat higher level, a piece of bronze and a barbed arrow-head suggest the Bronze Age horizon. Added to this, are previous discoveries of two horizons in the sand underlying this peat. The lower layers of sand contain flint implements of the Belgian Tardenois culture, while similar traces of the later Tardenois period are found in the upper layers of sand.

If the facts so far ascertained are completely substantiated, they form a very valuable chronological sequence. The question then arises as to their relation to the Scottish peat deposits studied by Lewis. These show fairly definite horizons roughly corresponding to Geikie's well-known climatic periods, namely, from below upwards, a Sub-arctic or Tundra zone, a Lower Forest, a Lower Turbarian or peat layer with some arctic plants in places, an Upper Forest, and finally an Upper Turbarian or deep peat layer.

Now, tree layers in peat are not *necessarily* an indication of climatic change. There is, for example, at present a general tendency for woodlands on poor soils (owing to the progressive leaching of the soil) to be replaced by moorland types of vegetation. Wood layers at the base of the peat may indicate a similar natural succession of vegetation. The study of plant successions on lowland peat also indicates that stages of woodland may alternate with stages in which peat is formed more rapidly, without the intervention of climatic change. It is obvious that extreme caution is necessary in interpreting the wood layers in peat deposits. The validity of the assumption made by Lewis that the Scottish peats show evidence of climatic change, largely rests on two facts. In the first place, the peats studied were mostly from high levels, where the general conditions are unfavourable to tree growth. Secondly, Lewis lays emphasis on the continuity of the main horizons almost all over Scotland. The Scottish wood layers are thus, apparently, signs of widespread changes. Samuelsson has reinvestigated the Scottish deposits and his main conclusions agree with those of Lewis.

So far as it can be ascertained, there is at present little evidence as to the archæological age of the main horizons. We can, however, obtain a rough correlation with the English results by indirect methods. According to Clement Reid, the submerged forests round the English coast are apparently of Neolithic age. Reid also estimated the period of coast depression to occur between 3500 and 1500 B.C., since when the coast has remained fairly stable. He pointed out that as no arctic or tundra species occur in these forests, they were probably formed a long time after the last considerable glaciation. The submerged forests apparently approximate to the tree layer at the base of the Pennine peat and the period of its replacement by moorland. Now along the Scottish coasts, the submerged forests are replaced by the 40-50 foot beaches, also of Neolithic date, and these beaches correspond in time to the Lower Turbarian stage of Lewis. If this approximation is correct, we then obtain the suggestion that the destruction of the Pennine forest coincides with the colder climate assumed for the Lower Turbarian. It would also indicate the Scottish Upper Forest to be approximately Bronze Age, while the Palæolithic horizons might lie below the Lower Forest. It is of interest to compare this approximate sequence with that obtained from the very detailed studies of Scandinavian peats. The following summary, taken chiefly from von Post, avoids most of the controversial points.

VEGETATION-CLIMATIC PERIODS.

1. Sub-Atlantic—Colder and moist.	Recent.	
2. Sub-Boreal—Drier: the warmest part of the post-glacial period	Bronze Age	*circa* 2000 to 1000 B.C.
	Stone Cists	Neolithic. English submerged forests are later than Littorina depression.
	Passage Graves	
	Dolmens	
3. Atlantic—Warm and moist	First Swedish Stage	Maximum extent of Littorina Sea.
	Transition — including Tardenoisien	
4. Boreal—warmer	Ending about 6000 B.C.	
5. Sub-Arctic	End of Palæolithic—beginning about 10,000 B.C. (De Geer).	

The warm Sub-boreal period in Scandinavia could scarcely fail to exert some influence in Scotland. Hence the estimate of the Upper Forest as being approximately of Bronze Age would receive some justification. The Neolithic Dolmen period apparently indicated at the base of the Pennine peat lies at the beginning of the Scandinavian Sub-boreal period, and we are apparently faced with the difficulty that the Scandinavian climate was becoming drier and more favourable to woodland vegetation while British climate was becoming colder (and moister ?). The evidence clearly suggests that either the Scandinavian and British culture periods were reached at different times or else that the climatic sequences were actually somewhat different. Much would depend, therefore, on the determination of cultural horizons in the Scottish peat. To these problems, one must in honesty add one more. The Pennine upland peats, as a whole, show few, if any, traces of Lewis's Upper Forest layer, although this is supposed to represent a time when the forest limit was very greatly raised both in Britain and Scandinavia. Further, in the Danish and Swedish lowland moors, this horizon is marked by a definite layer of "horizon peat"—the Sub-boreal surface.

A similar surface presents the only strikingly uniform horizon in the upper peat of the North Lancashire "mosses." It occurs about 3 to 4 feet below the surface, and below the peat is brown and partly decayed remains of Sphagnum and Eriophorum. Above this horizon, the peat is "white" and undecayed Sphagnum peat. Dr. Osvald, to whom I showed this, considered that it coincided with the Swedish Sub-boreal horizon. It certainly corresponds with a long period when the development of all the North Lancashire moors was arrested and when, according to Mr. Rankine, the surface was sufficiently firm to allow a corduroy road to be laid on it. Why is this horizon and that of the Scottish Upper Forest so conspicuously absent from the typical Pennine peats ? It must be confessed that these problems suggest that the climatic theories of peat succession are not nearly so firmly anchored in Great Britain as in Scandinavia. The further investigation of peats is likely to assume great importance and, in particular, the establishment of cultural horizons in the Scottish peats. The present indications clearly raise more problems than they solve.

New Measurement of the Velocity of Light.[1]

By Prof. A. A. MICHELSON, For. Mem. R.S.

THE velocity of light is one of the most fundamental of the constants of Nature, and this fact alone would justify the attempt to measure its value with the highest possible precision. But in addition to its scientific importance, it may prove to have a practical value if the result of such a measurement can be obtained with sufficient accuracy.

The mean of the various measurements thus far attempted is 186,330 miles per second, with an uncertainty of twenty or thirty miles. If this uncertainty could be reduced to one mile per second, the timing of light could be utilised to obtain distances between stations from 50 to 100 miles apart far more expeditiously and with an order of accuracy at least as great as that obtainable by the usual method of triangulation. Indeed, there are possibilities of utilising the velocity of light in cases where triangulation would be difficult or impossible.

An invitation tendered by Dr. G. E. Hale, then Director of the Mt. Wilson Observatory, and supported by Dr. J. C. Merriam, Director of the Carnegie Institution, made it possible to install the necessary apparatus on Mt. Wilson, with Mt. San Antonio, twenty-two miles away, as the distant station, during the summer of 1923; but smoke and haze from burning oil and from forest fires made it impossible even to test the feasibility of the method at so great a distance.

This feat was accomplished during the past summer with very promising results. The set-up of apparatus involved several important changes in the arrangement employed in previous investigations, the most important of which consisted in the substitution of an octagonal revolving mirror for the usual plane-parallel, together with the introduction of a system of reflectors which eliminated all direct and diffuse extraneous light. Finally, a simple method for returning the light from the distant station to the source was substituted for the plane mirror used for this purpose in previous work, and this equipment functioned so well that no readjustment was required during the entire two months of the work.

[1] Address delivered at the University of Pennsylvania on September 19, on the occasion of the observance of the centenary of the Franklin Institute. Reprinted from the Journal of the Institute for November 1924.

The advantage of the octagonal revolving mirror, in addition to the higher speed obtainable, lies in the possibility of receiving the return light on a succeeding face, thus eliminating the measurement of the angular deflexion of the returned beam; or rather, transferring this measurement to the construction of the octagon, the angles of which were tested and found to be equal, with an uncertainty of only one part in a million.

The determination of the velocity of light is thus reduced to the measurement of the distance between the stations, and of the speed of rotation of the mirror. The former operation was carried out by the U.S. Coast and Geodetic Survey, and the result obtained was 35,426·3 metres (about twenty-two miles), with an uncertainty of the order of only two parts in a million. The errors in the measurement of the speed of the revolving mirror were much greater, as no very effective means were employed to ensure its constancy. (This defect will be eliminated in the continuation of the work next summer.)

Notwithstanding the inconstancy of the speed of the mirror, the choice of the most favourable moment, when the speed was that corresponding to the frequency of a control tuning-fork, made the resulting uncertainty of the measurements of the order of one ten-thousandth part, which is about that of the mean of all the previous measurements. It is hoped that next year's work will furnish results four or five times more accurate.

The result of eight independent observations in the present preliminary work is, for the velocity of light *in vacuo*, 299,820 kilometres per second.

Following is a table of results of the more important investigations to date, with an estimate of the weight which should be assigned to each:

Investigator.	Method.	Distance.	Weight.	Velocity.
		km.		
Cornu	Toothed wheel	23	1	299,950
Perrotin	Toothed wheel	12	1	299,900
Michelson	Revolving mirror	0·6	2	299,895
Newcomb	Revolving mirror	6·5	3	299,860
Michelson	Revolving mirror	35·4	3	299,820

Obituary.

DR. FRANZ DOFLEIN.

IT seems but a short time since we deplored the premature death of Prof. Minchin, and now protozoologists have lost another distinguished leader, Prof. Doflein of Breslau, who died at the age of fifty-one on August 26. It is by his excellent text-book, "Lehrbuch der Protozoenkunde," that Doflein is most widely known. The fourth edition, which appeared in 1916, has been out of print for some years, and he had been working for the last three or more years on a fifth edition, although often interrupted by illness, aggravated by depression caused by the War. However, it is some satisfaction to learn that this new edition may be expected soon to appear, as it is being prepared for the press by Prof. Reichenow, of the Institute of Tropical Medicine in Hamburg.

Many in Great Britain will remember Prof. Doflein's charming personality and his readiness to help any one interested in his subject. He attended the Dundee Meeting of the British Association in 1912 and worked much at the Zoological Stations of Naples and Rovigno as well as in the Musée Océanographique at Monaco.

Franz Doflein was born in Paris in April 1873, his mother being of English origin and his father a German merchant. At seven years of age, on the death of his father, he was taken to Germany to be educated. In 1896 he went to the University of Munich to study medicine, but, coming under the influence of Prof.

Hertwig, he decided to devote himself to zoology. After graduating, several university posts were held by him in Munich until 1912, when he was appointed Weissman's successor as professor of zoology at Freiburg. Here he taught for six years, finally moving to Breslau in the autumn of 1918 to become Director of the Zoological Institute in succession to Kükenthal.

A many-sided naturalist, Doflein published work on crabs, ants and Bdellostoma as well as his numerous important papers on the protozoa. The first edition of his text-book appeared in 1901 under the title "Die Protozoen als Parasiten und Krankheitserreger." The second edition five years later was the first to be known as the "Lehrbuch der Protozoenkunde," and it included descriptions of free-living as well as parasitic protozoa. In collaboration with his friend Richard Hesse, Doflein recorded their observations on living animals in a popular book entitled "Tierbau und Tierleben," which appealed to a large circle of readers. In addition to this, he wrote popular books on three scientific expeditions undertaken by him—to the West Indies, Japan and Macedonia. The last, on his Macedonian travels, published in 1921, is illustrated with his own water-colour sketches.

In the early part of 1923, owing to continued ill-health, Doflein resigned his appointment in Breslau, and he died of pneumonia on August 26, 1924. Thus was tragically cut short a life of great achievement, for not only did he contribute much to biology himself but he also attracted many students to his laboratories, where they were allowed to follow their own lines of research, although always sure of his help in difficulty. His liberality and broad-mindedness were indeed part of that artistic temperament which delighted all with whom he came in contact.

THE *Chemiker Zeitung* of November 4 records the death, on October 25, at the age of seventy-two, of Dr. Carl Huggenberg, one of the pioneers among German public analysts. Huggenberg's name is associated with the well-known Analytical Institute founded by him at Chemnitz, where most of his public work was carried out. Born of Swiss parentage at Winterthur, he studied first at Zurich and later at Würzburg, where he became assistant to J. Wislicenus, and graduated in 1876. During the following three years he held an official appointment as analyst of foodstuffs in the Canton of Zurich. This special branch of applied chemistry was still in its infancy at that time, but in all the German towns, associations were being formed with the object of fighting against the adulteration of food. In 1882, the association which had been founded five years previously at Chemnitz by L. Friedrich, offered Huggenberg the direction of its laboratory. Here he found full scope for the development of his natural powers. His analytical skill, his comprehensive knowledge of chemistry, and his practical insight into the needs of industry and commerce were invaluable assets to him, and his opinion on technical matters was soon widely sought. His interest in technology led him to make numerous valuable investigations in oils, fats, and soaps, and he made numerous contributions to scientific literature on the refractometry of soap-fats, the recovery of waste fat, and on soap analysis. Until 1902 he also held the post of food controller at Chemnitz. In 1910 he retired to Zurich.

Current Topics and Events

THE Fishery Board of Scotland recently issued a notice to fishermen and others directing attention to the protection afforded to the grey seal under the Grey Seals Protection Act of 1914, which lays open to a penalty of 5*l.* any person taking, killing, or wounding grey seals during a close season, October 1-December 15. The publication of the notice has led to correspondence in the Scottish newspapers, the protection of this seal being condemned on the ground that it is increasing in numbers and is responsible for the destruction of some of the Hebridean cod fisheries. The weight of the evidence, however, seems to indicate that the grey seal is very rapidly decreasing in numbers on the west coast, and that the constant slaughter of the young in certain breeding haunts, their pelts being sent in considerable numbers to furriers in Glasgow, threatens the existence of the species in these waters. As regards the destruction of fisheries, the assertion is made that dog-fish and not cod form the diet of the seal, and that the destruction of seals and consequent increase of dog-fishes are responsible for the deficiency of cod. The point is an important one, which is left undecided by the assertions of the correspondents. It might readily be settled by the examination, by an expert in fragmentary fish remains, of a few series of stomach contents taken at appropriate seasons.

THE Field Museum of Natural History, Chicago, has arranged a series of twelve free programmes of moving pictures, with occasional lectures, illustrating natural history subjects, for children on Saturday mornings from October to December. The subjects include "Wild Animals I have known," by Mr. Ernest Thompson Seton, Capt. Kleinschmidt's "Polar Adventure," Theodore Roosevelt's "Visit to a Bird Reservation," and a number of films illustrating particular facts and aspects of zoology, botany, and geology. At each entertainment a little printed "museum story" is given to each child. This story gives, in simple language, some brief facts about the men, animals, and plants seen in the pictures, and directs the child to the case or cases in the Museum in which they are exhibited. By directing attention to the permanent exhibits in this way, opportunity is afforded to the child to crystallise the general impressions and information gathered from the films, and the real educational value of the scheme is thereby enormously enhanced. It surely is more than a series of entertainments, as the programmes are described on the syllabus. The experiment will be watched with great interest not only by those who believe in the vast potentialities of museums in education, but also by those who are convinced of the possibilities of the cinematograph as an aid in the same field.

THE proposal made by James Watt in 1783, that international units of weights and measures should be adopted, was the direct origin of the metric system. The strongest argument in favour of this system, as was pointed out by Sir Richard Gregory in his presidential address to the Decimal Association on November 26, is its international character. Scarcely a year passes without the addition of one or more countries to the list of those which have adopted metric weights and measures as their sole standards, while not a single country has introduced British measures to supersede its own. One of the latest additions to this Metric League of Nations is Japan, where metric weights and measures became official on July 1 of this year. The change was made as the result of the report of a Commission of Inquiry, which gave careful consideration to the advantages, from the points of view of industry and commerce, of the British, metric and other systems. Great Britain and the United States are responsible for so large a proportion of the world's trade that it would seem that this of itself would have led to the adoption of their weights and measures by other countries; yet whenever a country has appointed a Commission to inquire into the desirability of a change of units, it has always reported in favour of the metric system and never of the British. When Germany introduced the metric system, it seemed to be against immediate manufacturing interests on account of the overpowering superiority of British trade at the time. What decided the question then, as it should now in Britain, is that the metric system is an international system. At the annual meeting of the Decimal Association, Mr. A. J. Stubbs was elected vice-chairman of the executive committee, and the following were elected new vice-presidents: Sir Hedley le Bas, Mr. Llewellyn Atkinson, Mr. Harold Cox, and Mr. Gordon Selfridge.

AN interesting and little known chapter was added to the history of mechanical transport by Col. R. E. Crompton in his paper on "The Motor Car: its Birth, its Present, and its Future," read to the Royal Society of Arts on November 12. Col. Crompton's aim was avowedly "to vindicate the memory of that great Scotsman" Robert William Thomson, who was born on June 29, 1822, and died on March 8, 1873. A prolific inventor, Thomson as a young man came in contact with Faraday, Cubitt, and Stephenson, and then in 1844 set up in business for himself. The following year he took out his patent for the pneumatic tyre, an invention made possible by the rubber pioneers Macintosh, Goodyear, and Hancock. Thomson's tyre, however, was used but little, and Dunlop's re-invention of it forty years later was an independent one. By 1862 Thomson had a consulting practice in Edinburgh, and in 1867 he built a three-wheeled steam road locomotive for colliery work in Labuan, the wheels having heavy ring rubber tyres. Col. Crompton, then a young lieutenant in the Rifle Brigade in India, learning of this, got into correspondence with Thomson and was able to persuade the Government authorities to try steam locomotives on the Indian roads. In 1870 Col. Crompton came to England, spent some time at the home of Thomson, who by then was an invalid confined to his sofa, and supervised the building of two road engines, the "Chenab" and "Ravee." With a permit to test the engines on the roads at speeds greater than those allowed by the notorious Red Flag Act, the "Ravee" in September 1871 went from Ipswich to Edinburgh and back, hauling a large omnibus, and near Doncaster attained a speed of 25 miles per hour. In India the engines were in the first place used for Post Office work and then for military transport. It was the experience thus gained which led to Lord Roberts' advocacy of mechanical transport in South Africa in 1900. Thomson's achievements as one of the great pioneers of modern road haulage have often been acknowledged, and two years ago the Royal Automobile Club placed a tablet to his memory on the site of the house in which he was born in Stonehaven, Kincardineshire.

THE Engineering Department of the University of Cambridge has attained a leading and distinguished position among the engineering schools of Great Britain, and the illustrated descriptions of its new laboratories published in the *Engineer* for October 24 are of great interest. There are indications that the number of engineering students at Cambridge will become stabilised at about 500, which is approximately the present figure. The new laboratories stand on the Scroope House site in Trumpington Street, which occupies an area of about 4 acres. The buildings mostly consist of one-storied north-lighted structures of the factory type. The laboratories were completed and equipped in 1922 at an approximate cost of 100,000*l*., but no money was available for the construction of the projected two-storied lecture room block. In consequence, lecture rooms and laboratories are separated by a considerable distance, and the authorities hope that this inconvenience may be remedied soon by some generous benefactor; a further sum of 60,000*l*. is required. Provision is made in the laboratories for experimental work on heat engines, including engines and boilers, materials, structures, hydraulics, electrical engineering, including wireless telegraphy, and metallurgy. The equipment of all these laboratories is on a generous scale, and a large number of the machines has been presented by engineering firms. Whilst the Department also possesses workshops, we note with approval that students are encouraged to spend some of their vacations in real engineering workshops, and are advised, if possible, to serve in an engineering workshop for about six months prior to starting the course at the University.

NOMINATIONS for the award of the Elliot Medal of the National Academy of Sciences, Washington, for the year 1924 should be addressed to the secretary of the Academy. The terms of the award in the Daniel Giraud Elliot deed of gift are as follows: "One such medal and diploma shall be given in each year and they, with any unexpended balance of income for the year, shall be awarded . . . to the author of each paper, essay, or other work upon some

branch of zoology or palæontology published during the year as in the opinion of the . . . judges in that regard shall be the most meritorious and worthy of honor. The medal and diploma and surplus income shall not, however, for more than two years successively, be awarded for treatises upon any one branch of either of the sciences above mentioned. . . . The medal and diploma and surplus income may be conferred upon naturalists of any country and . . . no person acting as judge shall be deemed on that account ineligible to receive this annual gift . . . if, in the opinion of his associates, he shall . . . be entitled to receive them." The treasurer of the Academy reports that the Elliot Fund has increased since the original donation of 8000 dollars. The best idea of the kind of work for which this award was designed may be gathered from a résumé of previous awards: 1917, to Frank M. Chapman for his "Distribution of Bird Life in Colombia"; 1918, to William Beebe for his "Monograph of the Pheasants," volume i.; 1919, to Robert Ridgway for his "Birds of North and Middle America," Part VIII.; 1920, to Othenio Abel for his "Methoden der paläobiologischen Forschung"; 1921, to Bashford Dean for his "A Bibliography of Fishes," volume i.; 1922, to William Morton Wheeler for his "Ants of the American Museum Congo Expedition"; 1923, to Ferdinand Canu for his "North American Later Tertiary and Quaternary Bryozoa." Unlike other awards, the Elliot Medal is always for a special piece of research in zoology or palæontology completed and published in the year for which the award is made. The Committee particularly desires that nominations shall be received for foreign as well as for American work during the year 1924. Recommendations should be accompanied by a printed copy of the research submitted for consideration.

HEATHFIELD HALL, Birmingham, where James Watt lived from 1768 up to the time of his death, and where many of his experiments were carried out, having been sold, the former owner, Major Gibson Watt, has presented to the Science Museum, South Kensington, the contents of the attic workshop in which Watt worked. After Watt's death the room remained closed for some forty years, and all the contents still remain practically as he left them. A room, which will reproduce as closely as possible the attic at Heathfield Hall, is about to be constructed in the Science Museum on the ground floor of the new Museum buildings not far from the two Boulton and Watt engines which are preserved there. In this room the furniture, tools, two or three machines which Watt used, as well as many trial pieces, etc., will be placed on view.

ACCORDING to messages which have appeared in the daily papers, photographs were successfully transmitted by radio across the Atlantic in some tests carried out on Sunday, November 30. The transmitting apparatus was installed at Radio House, London, and the radio signals were picked up at Long Island and transmitted to New York by land lines. Brief descriptions of the apparatus have been issued, from which it appears that a photographic film is attached to a rotating glass cylinder and the actual emission of radio signals is regulated by a photo-electric cell under the influence of the light which traverses the photographic film. After each revolution of the drum carrying the film, the latter is automatically moved by a fixed amount; in the recent experiments the shift was $\frac{1}{128}$ in., but it is stated that $\frac{1}{64}$ in. would be sufficient. It takes about twenty minutes to transmit a half-plate film. The invention has been developed by Mr. D. H. Ranger, of the Radio Corporation of America. According to the New York correspondent of the *Times*, the receiving apparatus executes on paper a pen-and-ink reproduction resembling an engraving, and it is stated that the photographs transmitted in the test were easily recognisable. The general principles of the transmission of a film record by means of the action of light on a selenium cell were described by Prof. A. O. Rankine in articles in NATURE of February 5, 1920, p. 604; October 27, 1921, p. 276; and June 2, 1923, p. 744.

PROF. RISLER, working in the Laboratoire Physiologique des Sensations at the Sorbonne, has produced tubes filled with air or other gas at low pressure, excited by high-frequency current, with phosphorescent and fluorescent materials and pigments, either applied to the tubes or incorporated in the glass. The result is an emission of light, with little or no long wave-length red or infra-red radiation and no green, to which the name "cold light" has been applied. It is claimed that a large tube gives 12,000 candle power with an input of 2·5 kilowatts. A special arrangement of the electrodes maintains the pressure automatically at the optimum point, so that some of the tubes have worked for 9000 to 10,000 hours without any noticeable diminution in their illuminating power. A large quantity of ultra-violet radiation is given off, and the tubes have proved valuable for therapeutic purposes. When the current is switched off, the tubes continue to glow with phosphorescent light, the colour of which is different from that emitted previously, and the tubes appear suitable for use in advertising. Particulars of the tubes can be obtained from Mr. D. L. Daponte, 147 Cannon Street, E.C.4.

PROF. A. W. BICKERTON has been elected an honorary member of the New Zealand Astronomical Society in recognition of his work on cosmic evolution.

PROFS. THEODORE LYMAN, of Harvard University, and Gilbert N. Lewis, of the University of California, have been elected honorary members of the Royal Institution, London.

MR. E. LEONARD GILL, assistant in the Natural History Department of the Royal Scottish Museum and formerly Curator of the Hancock Museum, Newcastle-upon-Tyne, has been appointed Director of the South African Museum in succession to the late Dr. Louis Albert Péringuey. The assistantship in the Royal Scottish Museum therefore becomes vacant and applications are invited.

AT the opening of the hundred and fifty-fourth session of the Royal Physical Society of Edinburgh, the following new office-bearers were elected: *President*, Dr. James Ritchie; *Vice-Presidents*, Dr. Marion Newbigin and Prof. J. Arthur Thomson; *Secretary*, Dr. H. M. Vickers; *Assistant Secretary*, Prof. J. Russell Greig; *Librarian*, Mr. J. Kirke Nash; and *Councillors*, Prof. D'Arcy W. Thompson, Principal O. Charnock Bradley, Prof. J. H. Ashworth, Prof. J. Graham Kerr, Dr. J. R. Henderson, and Mr. Hugh Miller.

THE Rivers Memorial Medal of the Royal Anthropological Institute for the year 1924 has been awarded to Dr. A. C. Haddon. This is the first occasion on which the medal has been awarded. In future one or more medals will be given annually in recognition of meritorious anthropological work in the field, in memory of the late Dr. W. H. R. Rivers, who was president of the Royal Anthropological Institute at the time of his death. Apart from Dr. Haddon's unquestioned claims as a field worker in ethnology, it is peculiarly appropriate that he should be the first recipient of this honour in view of the close association of Dr. Rivers with him when the latter first took up his investigations among primitive peoples.

A GROUP of papers on "Base Exchange in Soils" will be presented for discussion at a meeting of the Faraday Society to be held in the rooms of the Chemical Society, Burlington House, London, on Tuesday, December 9, at 4.30-7.30 P.M. The chair will be taken by Sir Daniel Hall, scientific adviser to the Ministry of Agriculture, and an introductory address will be given by Dr. D. J. Hissink, of Groningen. Further particulars may be obtained from the Secretary of the Faraday Society, 90 Great Russell Street, London, W.C.1. Papers will be presented by Prof. N. M. Comber (University of Leeds), Messrs. H. J. Page and W. Williams (Rothamsted Experimental Station), Prof. G. W. Robinson and Mr. Rice Williams (University College, Bangor), Mr. S. J. Saint (University of Leeds), and Mr. E. A. Fisher (Research Association of British Flour-millers).

AN extra meeting of the Institution of Civil Engineers will be held on Thursday, December 11, at 6 P.M., in conjunction with the Institutions of Mechanical Engineers, Electrical Engineers, and Naval Architects, the Institute of Marine Engineers, the North-East Coast Institution of Engineers and Shipbuilders, the Institution of Engineers and Shipbuilders in Scotland, the Institute of Chemistry of Great Britain and Ireland, the Institution of Gas Engineers, the British Electrical and Allied Manufacturers' Association, and the British Engineers' Association. These bodies are co-operating in the work of the special committee on tabulating the results of heat-engine and boiler trials, and the chairman of the committee, Capt. H. Riall Sankey, will submit for discussion: "Standards of Comparison in connection with the Thermal Efficiency of Steam Engines."

THE before-Easter lecture arrangements at the Royal Institution have just been issued. The general courses will begin on Tuesday afternoon, Jan. 13, at 5.15, when Prof. A. Fowler will commence a course of two lectures on the analysis of spectra; on succeeding Tuesdays there will be two lectures by Dr. H. R. Hall on the prehistoric Greek and ancient Egyptian civilisations, four by Prof. Barcroft on the colour of the animal creation, two by Prof. E. N. da C. Andrade on the evolution of the scientific instrument, and two by Prof. A. S. Eddington on the internal constitution of the stars. Thursday afternoons at the same hour beginning on Jan. 15, Mr. J. S. Huxley will give two lectures on the courtship of animals and its biological bearings; Sir William Bragg, four on the properties and structure of quartz; Sir A. Smith Woodward, two on dinosaurs; Dr. Leonard Hill, two on the biological action of light; and Mr. T. Thorne Baker, two on chemical and physical effects of light. The Saturday lectures will include four by Sir Ernest Rutherford on counting atoms, and two by Prof. J. H. Ashworth on a zoological topic. The Friday evening meetings begin on January 16 with a discourse by Sir William Bragg on the investigation of the properties of thin films by means of X-rays. Succeeding discourses will probably be given by Dr. A. W. Crossley, Profs. J. W. Gregory, R. W. Chambers, T. H. Pear, Gilbert Murray and J. W. McBain, Principal Irvine, Mr. W. B. Hardy, Sir Ernest Rutherford, Sir Daniel Hall and other gentlemen.

THE autumn issue of *Bird Notes and News*, the journal of the Royal Society for the Protection of Birds, is a double Dominions number and contains interesting papers written by prominent bird-protectionists relating to the work of bird protection in Australia, New Zealand, Canada, British Columbia, Newfoundland, and South Africa. A comprehensive report on the bird-life of the sanctuaries in the Royal Parks in London, by a member of the sanctuaries committee, forms an enlightening and encouraging leading article; and the effort the Society is making to combat the oil menace to sea-birds is further evidenced.

THE National Research Council of Japan has initiated an active programme of scientific publication, in several series of "Japanese Journals" under the separate headings of chemistry, physics, geology and geography, botany, zoology, medical sciences, engineering, mathematics, and astronomy and geophysics. The first two of these journals each appear in ten numbers annually, the third appears quarterly, while the remainder are occasional publications. The second part of volume ii. of the *Japanese Journal of Astronomy and Geophysics* has just been issued, and contains six memoirs, occupying about sixty octavo pages. The papers cover a wide range of interests—precise levelling, theory of monsoon rainfalls, gravitational fields, thermal expansion of rocks, and tidal undulations — and in some cases originate from

research institutes, independent or connected with universities or colleges. They indicate a highly satisfactory state of activity and interest in geophysical research in Japan. All the papers are in English.

INSTRUCTIONS and information relative to wireless reports of weather on the coast of Brazil have been issued by the Brazilian Meteorological Service. The Director, Señor Sampaio Ferraz, who is responsible for the issue of the information, is thoroughly conversant with the meteorological requirements. With the view of assisting navigation, twelve transmitting stations have been established on the coast and send observations six times a day, every four hours, of the force and direction of wind and the state of weather and sea. In case of storms and dense fogs, these frequent messages should prove useful to approaching vessels. The reports are expressed in Portuguese, but very simply. The messages from the transmitting stations are sent on 600 m. waves spark. Rio's special messages, sent out twice daily, include detailed forecasts for the south coast of the State of Rio de Janeiro and general forecasts for the rest of the southern Brazilian coast and up to Buenos Aires; the first part, organised by the international code, gives barometric pressure, force and direction of wind, state of weather and air temperature. The instructions contain specifications of the international codes, and every facility is afforded for commanders navigating these seas to draw for themselves weather charts which will give them full information of the conditions of the weather over the whole neighbourhood.

THE British Dyestuffs Corporation, Ltd., Manchester, has issued a booklet entitled "Medicinal Products: A booklet issued to the Medical Profession," which gives an account of the various dyestuffs which have found a therapeutic application, and also of some chemicals that are used as reagents in clinical tests. The formula is given in each case, together with a considerable number of references to papers in which the use of the products is described. The main section is devoted to a consideration of the flavine antiseptics, and is followed by one on the di- and tri-phenyl-methane series: namely, auramine, crystal violet and brilliant and malachite green. Among other dyes considered may be mentioned trypan blue, Biebrich scarlet, gentian violet, methylene blue and picric acid with their therapeutic uses, and indigo-carmine which has been used for testing the function of the kidneys. In the last section a brief account is given, amongst other compounds, of benzidine, dimethylp. aminobenzaldehyde and phenylhydrazine hydrochloride and their use in clinical tests. The booklet should be useful to all those who desire information on the constitution and reactions of any substances in the above groups which they may happen to be using.

Our Astronomical Column.

THE GREAT FIREBALL OF NOVEMBER 11.—Mr. W. F. Denning writes that the fireball of November 11, 5 h. 40 m. G.M.T., was observed by a great number of persons in Ireland and extreme north of England. Sixty-nine accounts of it have been received, and though the observers were taken by surprise and most of them inexperienced in recording meteors, their results are in very fair agreement. At most of the stations the moon, which was nearly full, was near the beginning point of the meteor and furnished a useful guide to position.

The fireball had an exceptionally lengthy flight, and a very long duration, the average time being 33 seconds, when proper allowance is made. The whole of the luminous course appears to have extended over 510 miles, and the velocity was 16 miles per second. It passed from over the North Sea, 80 miles east of Hartlepool, across the extreme north of England and south of Scotland and onwards over the Atlantic Ocean, to Long. $11\frac{3}{4}^\circ$ west, Lat. $56\frac{1}{2}^\circ$ north. The average height was about 53 miles. The radiant point was as nearly as possible at $31^\circ - 6^\circ$ near Mira Ceti. As the fireball sailed along in its nearly horizontal course it showed some curious variations of colour; in the head blue and yellow predominated, while flakes of red were distributed along the tail. The effect produced was that of a brilliantly coloured snake-like object wriggling its course through our resisting atmosphere. Some of the observers compared the oval head to the size of a football; others thought it equal to the moon's diameter or to half the latter value. Adopting the smaller estimate, the nucleus would be half a mile in diameter, but this included the outlying flames and luminous off-come resulting from its combustion. The real size of the solid nucleus may not have been more that two or three feet.

OBSERVATIONS OF MARS.—*L'Astronomie* for October contains a number of drawings of the planet, made in September at Juvisy and Meudon. The large dusky areas are represented in much the same manner as by the American draughtsmen, but the canals as a rule are broader and more diffused; some of them appear on almost all the drawings, so that there is practically a consensus as to the existence of the markings, the difference only extending to their exact aspect. Thus, M. Quénisset on September 19 drew the Ganges as a very broad dark streak, fully 300 miles wide, with straight parallel edges.

M. E. M. Antoniadi has again observed the planet with the great Meudon refractor and contributes some very beautiful drawings. As is well known, he rejects the geometrical aspect of the canals and draws them as broad irregular shadings. He reproduces for comparison his drawings of Pandoræ Fretum made in 1909 and 1911, which show a marked change of intensity of this region from one year to another. He lays stress on the planet being a living world, and is inclined to return to the old notion that those dusky areas that do not show a seasonal change of tint are veritable seas.

M. Quénisset also observed Uranus with the Meudon refractor, and distinctly saw two equatorial belts and dusky regions at the poles. The aspect was quite like that of Jupiter except that the belts were nearly vertical.

Research Items.

MEDIEVAL METALLURGY.—An interesting article on medieval metallurgy, by M. L. Becker, appears in the Memoirs and Proceedings of the Manchester Literary and Philosophical Society (1923–1924, No. 4). No important metallurgical information of early times can be obtained from works prior to those of Dioscorides (first century A.D.), who describes brass and the recovery of zinc oxide. Pliny at the same period describes the smelting of metals, but he does not appear to have had practical experience in this direction. The really important literature dates from the eleventh century onwards, and includes the works of Theophilus and Agricola. The latter's contributions to metallurgical science, embodied in his book "De Re Metallica," are considered in detail, many illustrations being reproduced.

PAUPERISM IN THE UNITED STATES.—Prof. Raymond Pearl contributes to *Science* of October 31 an interesting note on the racial composition of paupers in public almshouses in the United States. Between 1910 and 1923 the proportion of foreign-born white paupers decreased from 42·6 per cent. to 32·6 per cent. The countries of origin which showed the greatest proportional excess of the paupers, having regard to their percentage shares in the whole population, were Ireland, Germany, and England, in that order. "With a few trifling exceptions," writes Prof. Pearl, "all the countries from which the present law *encourages* immigration contributed to almshouse pauperism in 1923 in *excess* of their representation in the population in 1920. On the other hand, again with a few trifling exceptions, those countries from which the present immigration law was especially framed to *discourage* immigration appear in the lower part of the diagram, because they contribute a *smaller* proportion to almshouse pauperism in 1923 than their representation in the general population in 1920."

ASYMMETRY OF THE AXIS IN THE PRIMATES.—In the course of a comparative study of the mammalian axis, Dr. Delattre has found that the axis of primates, and particularly of the anthropoids, is asymmetrical in a large proportion of cases. In the current issue of the Bulletin of the Société d'Anthropologie de Paris (Sér. VII. t. iv. fasc. 4-5-6), he describes the deformation and endeavours to account for its occurrence. Beyond the primates it does not occur among the mammalia except in certain carnivora and ungulates. There are several theories which are held to account for its occurrence in man, such as unequal action of the spinal muscles on one side. Any inequality in the lower limbs involves a compensating curvature in the vertebral column, as will also any deformity or defect tending to unilateral action. Although an inequality of the lower limbs is of sufficiently common occurrence among the primates, the asymmetry of the axis is rather to be attributed to a special attitude which is an accompaniment of the arboreal life. One of the upper limbs being employed constantly in prehension is habitually raised and held in a more forward position than the other. The torsion of the trunk and the constant thrust forward of the head causes an unequal action of the muscles which produces a deformation of the cervical vertebræ.

HISTORY OF CIVILISATION.—An Occasional Paper (No. 6) lately issued by the Royal Anthropological Institute is of the first importance for students of races and history. The early pottery of the near East has been summed up by Mr. H. Frankfort of Amsterdam, in a thesis for his M.A. degree in the University of London. He deals with Mesopotamia, Syria, and Egypt and their earliest interrelations in 142 well-illustrated pages. During the last third of a century our view of the past has been immensely enlarged; the four civilisations known before the present one have been extended now to eight. The great mass of new facts remained mostly in their original monographs, in which they had been partly explained. The summing up of them as a whole, in full view of all the material, was a work much needed, and Mr. Frankfort has done it with great diligence, searching out unpublished specimens, and with remarkable judgment and sanity. He carefully distinguishes the ideas often vaguely expressed, of racial and artistic terms, and seeks to secure every precision and definition available. The discussion of Mesopotamian material leads to the conclusion that the earliest Susian civilisation was crushed by drought, which drove the people down to the rivers. They were neither Semite nor Sumerian, and the Sumerians came up later from the Persian Gulf. Their possible Indian connexion has been rendered much more likely by the recent discovery of quasi-Sumerian engraving and signs in India. As to Egypt, it is well to find that the explanations given at the time of new discoveries during the last quarter of a century hold good in almost every point. The scantiness of the Asiatic discoveries is scandalous, now that the regions are more accessible, and sites are liable to be destroyed by commercial business. The opportunity will not keep, and both men and money are wanted speedily for Eastern research in civilisations.

FUNGI AND EPILEPTIFORM CONVULSIONS.—In the Transactions of the Mycological Society, 10, p. 121, Prof. J. Russell Greig describes the association of fungus spores with epileptiform convulsions in dogs. In three cases showing the symptoms (two of which died), the fæces and intestines were found to contain spores of *Tilletia Tritici*, the stinking smut of wheat. These were present in very large quantity and were conceivably derived from straw used for bedding. In the cases examined, no macroscopic lesion was visible in the body, but in one case in which the cranium was also investigated, an acute cerebral meningitis was observed, associated with numbers of spores. The fungus spores are often present as isolated specimens in the fæces of normal dogs. There appears to be evidence that they can be absorbed by the intestines, though how this is accomplished in the case of an inert body of about 18μ in diameter, remains to be determined.

TRANSPIRATION OF XEROPHYTIC PLANTS.—It is now generally recognised that the thick cuticle, sunken stomata and other structures characteristic of plants growing in dry places do not necessarily produce any noteworthy modification in the rate of transpiration. This point has now been examined for a number of typical Australian xerophytes by Mr. H. W. Wilson (Proc. Roy. Soc. of Victoria, 36, N.S., pp. 175-237), who was unable to find that these plants had any special powers of accommodation when subjected to rapid increases in temperature or to hot winds. The so-called xerophytes are, in fact, provided with a high average number of stomata, and they respond very rapidly to changes in the evaporating power of the air. The phyllodes of the Acacias and the leaves of the Eucalypts in particular, are regarded by Mr. Wilson as almost perfect transpiring organs. One of the curious features of the results to which no reference is made, is that the average transpiration rate per

million stomata bears no apparent relation in different species to the depth to which the stomata are sunk or to the degree to which they are protected by hairs or other excrescences.

BROWN BAST DISEASE OF RUBBER TREES.—In the *Malayan Agricultural Journal*, Vol. 12, September and October 1924, pp. 290-343, Messrs. A. Sharples and J. Lambourne record a very large number of further field experiments upon this subject in continuation of the experiments referred to in NATURE of February 17, 1923, p. 234. These experiments leave them still more firmly convinced of the physiological origin of this disease, as opposed to the bacterial origin suggested by P. E. Keuchenius. On the other hand, they are unable to agree with Prof. J. B. Farmer and Mr. A. S. Horne that phloem necrosis is a significant primary feature of the disease, as they find lignification of the sieve tubes a common feature of the phloem in healthy trees. They conclude that over-extraction of latex is the most important factor in initiating the disease, and suggest that this may cause an excessive loss of water to the plant at times or seasons when this loss of sap seriously affects the water balance in the tissues. These authors seem somewhat pessimistic as to the possibility of developing successfully high yielding plantations by methods of vegetative propagation (bud-grafting). It is difficult to select the tree in which high yield of latex is an intrinsic quality and not the result of favoured position and climate, and difficult to know whether such high yield is associated with resistance to brown bast disease. The authors argue that such high-yielding trees will have leaves more liable to fungus attacks, though their reasons for such a pessimistic conclusion do not read very convincingly.

FOG AT THE SCILLY ISLES.—Fog frequency at Scilly during summer months in relation to weather types indicated by barometric pressure is discussed by Mr. E. G. Bilham in Professional Notes, vol. 3, No. 37, issued by the Meteorological Office, Air Ministry. The investigation is somewhat tentative, more complete work being in hand, but as fog at the entrance to the Channel is of considerable importance to seamen, the facts at present to hand are published. In the summer months "fog" as distinct from "mist" is reported at Scilly on one day in seven, and including "mist," the frequency is at least twice as great. Only days with fog are included in the present inquiry. The period dealt with is the fourteen years 1905 to 1918, which gives 1288 days, and as there were 192 fogs the chances against fog are nearly 6 to 1. Of the total fogs, 61 occurred in June, 60 in July, and 71 in August. In individual months the fogs varied from none in August 1905 to 12 in June 1915. In individual years the number of fogs for the three summer months combined varied from 8 in 1909 to 24 in 1914. The numbers are given for each of several types of pressure distribution. Illustrations are given of the several foggy types and of the clear weather types. With a large area of high barometer over Scandinavia and several smaller ones to the south-west, the chances are only 1·4 to 1 against fog at Scilly. No fog was recorded during the summer months in 14 years at Scilly with a "V" shaped depression over the east of England or with a high barometer over Scandinavia and low over Mediterranean. With high barometer to the north-west of the British Isles and low over the north of France, the chances against fog are 24 to 1.

THE RECOIL OF THE ELECTRONS WHICH SCATTER γ-RAYS.—Mr. D. Skobelzyn describes, in the *Zeitschrift für Physik* of October 14, an investigation of the γ-rays of radium, in air, by the Wilson cloud method. A magnetic field was employed, perpendicular to the path of the γ-rays. This caused the resulting β-rays to move in spiral and often in circular paths. It prevented β-rays produced on the walls from penetrating into the space surrounding the γ-ray beam, and made it easy to investigate the β-rays from the gaseous atoms. Although the energy given by a hard γ-ray to an electron is in some cases nearly equal to $h\nu$, in many others it is only a small fraction of this quantity. It is also found that the initial velocity of the electrons has always a forward component, and that the energy depends on the angle θ between the direction of the initial velocity and that of the γ-ray, being on the average smaller as θ increases. These results are in accord with the hypothesis of Compton that, in the case of the lighter atoms, the secondary β-rays are recoil electrons, and contrary to that of Wilson and Bauer, according to which the scattering of the γ-ray takes place as a spherical wave, and that the whole elementary impulse of the radiation $h\nu/c$ is given up to the electron.

HEAT INSULATORS.—Special Report No. 5 by the Engineering Committee of the Food Investigation Board (First Report on Heat Insulators, Experiments. Second Edition. London: H.M. Stationery Office. 2*s*. net), deals with the first series of measurements made by Dr. E. Griffiths at the National Physical Laboratory of the heat conductivities of some of the heat insulators used in the construction of refrigerating stores. Dr. Griffiths finds that the heat conductivities of good dry cork, slagwool, charcoal and wood fibres at ordinary cold stores temperatures are all about 0·00011 C.G.S. units. Different brands of the same material differ to some extent in conductivity, and some of the materials at present used for heat insulation are liable to deterioration in situations where they may be subjected to heat or vibrations. In one case the conductivity had increased 40 per cent. Of the 17 materials tested, one—expanded rubber—appears to be little known as a heat insulator although its heat conductivity is about the same as that of cork.

COAL DUST EXPLOSIONS.—Prof. H. B. Dixon's presidential address before the Manchester Literary and Philosophical Society, which dealt with coal-dust explosions, is printed in the Memoirs and Proceedings of the Society for 1923–1924. A general account of the work carried out at Eskmeals is given. A coal-dust cloud can be ignited and can propagate a flame, but this cloud must pre-exist before the flame reaches it. The effect of the presence of inert dust varies; if the explosion wave is set up in pure coal dust it will continue to travel for some distance when it meets a dust containing as much as 75 per cent. of inert dust. A mixture of equal parts of coal dust and inert dust may propagate an explosion, provided there is an intense explosion flame to start it; such a mixture may be exploded by the discharge of 24 oz. of blasting powder.

DIAZONIUM TETRACHLOROIODIDES AND PLUMBICHLORIDES.—These compounds are described by F. D. Chattaway, F. L. Garton, and G. D. Parkes in the October issue of the Journal of the Chemical Society. The tetrachloroiodides are among the most stable of diazonium derivatives and they separate as yellow crystals when cooled solutions of diazonium chlorides are poured into cooled concentrated hydrochloric acid solutions of iodine trichloride. They are decomposed by hydriodic acid to the corresponding iodobenzene derivative; on heating with alcohol the diazo-group is mainly replaced by chlorine. Diazonium plumbi-

chlorides are prepared as above with the substitution of lead tetrachloride for iodine trichloride. They react with hydriodic acid and alcohol in the same way as the tetrachloroiodides. They all decompose explosively at a definite temperature; the tetrachloroiodides melt sharply, although always with decomposition.

EXPLODING AMMONIA WITH ELECTROLYTIC GAS.—The products obtained by exploding ammonia with varying amounts of oxygen and of electrolytic gas have recently been examined by J. R. Partington and A. J. Prince, the results being published in the Journal of the Chemical Society for October. Mixtures of electrolytic gas with ammonia are explosive when the former constituent is in slight excess; 79 per cent. of the ammonia is decomposed under these conditions. Complete decomposition occurs when the proportion of electrolytic gas just exceeds 75 per cent. When more than 1·6 parts of ammonia are exploded with 1 part of oxygen, the latter unites preferentially with the hydrogen, leaving a residue of nitrogen and excess hydrogen. When less than 1·6 parts are used, oxides of nitrogen are formed; the maximum oxidation of nitrogen is 16 per cent. and occurs when the ratio of the exploding gases is 1·22 : 1. The amount of nitrogen oxidised when mixtures of nitrogen, hydrogen, and oxygen are exploded is always less than when the ammonia which would be formed from these mixtures is exploded with the same ratio of oxygen.

PENANG HILLS RAILWAY.—The island of Penang consists of mountainous and broken country and is situated not far from the equator. The capital, Georgetown, is at sea-level, and the climate is trying for Europeans. It is therefore not surprising that a hill suburb is growing up on Penang Hills. Access to the summit has, until quite recently, been possible only by a tiresome and difficult journey by hill track some 5 miles long, and impossible for vehicles of any kind. A new railway was completed and opened on October 21 last year, the work having been carried out under the direction of Mr. A. R. Johnson of the Federated Malay State Railways. An illustrated account of this railway appears in *Engineering* for November 14, and the scheme has novel features. The total length is 1 mile 435 yards, and the upper station is 2381 feet above sea-level. In any funicular railway, the haulage engine has to move not only the cars but also the haulage rope, which may be considerably heavier than the useful load. The load on the engine is variable as the relative positions of the cars alter. The ideal arrangement is one in which the tractive force required from the haulage engine is a constant, and this effect is secured by making the profile of the railway a parabola. The Penang Hills Railway has been set out with a parabolic profile, and one of the striking features of the line is not only the practically constant loading of the haulage engine, but also the remarkably small power which it demands for its operation. The line is divided into two sections, and there is an electric-motor-driven winding engine at the top of each section. At the bottom of each section a short circular curve, tangential to the parabola, has been introduced. The object of this is to ease the starting grade so that the load does not rise above the normal during the period of acceleration. The total time for the journey to the top is about 25 minutes. The article is of interest also from the constructive point of view on account of the difficulties of the site.

A POCKET MICROSCOPE.—We have received through Messrs. Ogilvy and Co. (18 Bloomsbury Sq., W.C.), the British agents, an example of the new Leitz "Minor" folding microscope, which when folded is contained in a leather case only 6 in. long. Coarse focussing is by sliding tube and fine focussing by a screw collar encircling the tube. By means of a duplex combination lens, two eyepieces and the draw-tube, magnifications of from 50 to 250 diameters may be obtained. A low power objective can also be supplied giving magnifications of from 7 to 26 diameters. The folding foot may be so adjusted as to form a handle, so that with the low power objective the microscope may be used as a hand lens. The microscope is a handy little instrument, very suitable for field work or travel.

A NEW DEW-POINT HYGROMETER.—The issue of the *Physikalische Zeitschrift* for September 15 contains a short description of a dew-point hygrometer constructed by Dr. M. Holtzmann of the Geophysics Department of the Central Physical Observatory of Leningrad. A polished copper tube 2 cm. in diameter and 15 cm. long is placed with its axis vertical, and round its upper end is wound an insulated wire through which an electric current is sent so as to warm the upper end of the tube a few degrees above the temperature of the air. A short distance below the coil, a horizontal line is drawn round the tube and the two wires of a thermo-couple are soldered to the tube at points on the line. A stream of liquid at a temperature two or three degrees below the dew-point is then sent up the tube, and its speed so regulated that dew is deposited on the tube up to a point above the line. The stream is then stopped and the heating current reduced until the top edge of the deposit of dew descends to the line. The electromotive force of the thermo-circuit is then read on a galvanometer in circuit. The author claims that the instrument gives the dew-point with an accuracy of 0·02° or 0·03° C.

A NEW SPECTROMETER.—We have received from Messrs. Bellingham and Stanley, Ltd., of 71 Hornsey Rise, N., their catalogue of spectrometric apparatus, polarimeters, and refractometers, containing particulars of instruments suitable for many types of work. Particular attention is directed to a new model universal spectrometer, which may be used as a wave-length spectrometer for the visible and ultra-violet spectrum, a monochromatic illuminator, an infra-red spectrometer, a spectrograph, or, with the addition of the Bellingham and Stanley photometer, a high precision spectrophotometer. The instrument is arranged on the Littrow principle. Light from the slit is directed by a small totally reflecting prism to a concave mirror and thence to a 30° prism, from which it returns to the mirror and passes to a second slit, carrying an eyepiece adapter, by means of which the particular spectrum line required is isolated. The prism may be rotated so as to bring the required line into view. The prism and mirror inserted vary with the purpose for which the instrument is to be used. The photometer necessary to convert the instrument into a spectrophotometer has a number of new features in its design. The polarimeters, of which there are several models, consist of two solid components of Iceland spar mounted in such a way that no totally reflecting cement is required, and the risk of disintegration is reduced to a minimum by locating the sharp edge in one of the natural cleavage planes of the crystal. The refractometers include a high accuracy critical angle instrument specially designed to meet the objections to existing instruments working on the same principle.

Anniversary Meeting of the Royal Society.

THE report of the Council of the Royal Society, presented at the anniversary meeting on December 1, records that a bequest of 10,000*l.* has been received "for the prosecution of original research in medicine for the prevention of disease and relief of suffering with special attention to tropical diseases in British possessions and to cancer and tuberculosis." On the recommendation of the sectional committee for physiology, the subject of kala azar has been chosen for investigation, in view of its grave and increasing prevalence in India, and of the complete ignorance which exists as to the mode of infection. A further donation of 500*l.* has been received from Mrs. Tyndall, who in 1910 made a generous gift of 1000*l.* for the purpose of encouraging and furthering research in all matters pertaining to mining. It is the wish of Mrs. Tyndall that the income from this additional donation be used, at the discretion of the Tyndall Mining Bequest Committee, solely as a fund to meet out-of-pocket expenses incurred by the Tyndall research student in the carrying out of his investigations. The nineteenth and final volume of the Catalogue of Scientific Papers is now in the printers' hands. This contains about 44,200 entries under the letters T-Z, bringing the total number of entries for the period 1884–1900 to about 384,000. The publication of this volume will complete the great work of cataloguing the scientific papers of the nineteenth century. The first volume of this permanent record of the achievements of science during the period 1800–1900 was published in 1867. The cost of the catalogue has been very great, and might have prohibited the completion of the undertaking but for the assistance of the late Dr. Ludwig Mond and other donors, and for the generosity of the Syndics of the Cambridge University Press. Even apart from this assistance the total direct cost to the funds of the Royal Society has amounted to 24,970*l.*

President's Address.

In his address, Sir Charles Sherrington referred to the scientific careers and work of the twenty fellows, one foreign member, and one on the selected list of election as a fellow, who had died since the anniversary meeting of last year. He referred also to the original work on the emission of electrons from hot bodies carried out by Prof. O. W. Richardson, who was recently appointed to the third Research Fellowship founded by the munificence of Sir Alfred Yarrow, and to the retirement of Sir Arthur Schuster from the foreign secretaryship of the Society, after completion of the usual four years of office. The remainder of Sir Charles Sherrington's address is summarised below.

If I may finally pass for a moment to biological progress which the year has witnessed, I would advert to the work which Prof. Magnus and his collaborators have recently brought to approximate completion, their admirable research in nerve-physiology engaging the Utrecht laboratory during the past fifteen years. Its field has lain in nervous mechanisms which, though the highest part of the brain can have touch with them, can yet of themselves work wholly reflexly and separably from mind.

A number of simpler acts, studied for the most part in lowlier animal forms, have, of course, long been known to stand in that relation to the higher brain. But the Utrecht researches prove a like relation, and in the superior mammals, for acts surprisingly complex, the assumption and maintenance of the erect posture of walking, running, and so forth, in all their ordinary completeness. Not only have Magnus and his colleagues observed this, but they have also analysed the reflex processes by which these acts are thus accomplished. They have traced the seat and nature of the stimuli at work, the principles of the co-ordination of the nervous arcs and muscles involved, and indeed all the mutual interaction, which grade and secure the nicety of adjustment exhibited in such complexity.

Plant-growth orientates itself in regard to the line of gravity, geotropism; and so in the rabbit, cat, and monkey, standing, walking, running, with one element in common, the erect attitude, are shown by Magnus and de Kleyn to be, shortly said, refined geotropic reflexes. Any position other than the erect excites in the reflex animal restoration of its erectness. The head, for example, is righted by an act having its unconscious source in the pull and pressure of two microscopic stones in the special pair of tiny gravity organs bedded in the skull. With righting of the head goes rotation of the eyeballs in the opposite sense, keeping the vertical meridian of each retina in correspondence with the actual vertical. Appropriate reflexes bring the whole animal from any other position into the symmetrical right-side-up position. The well-known manœuvre which enables the cat, when inverted and falling from a short height, to right itself in the air during its fall, alighting squarely on its feet, is shown by Magnus and his colleagues to be executed perfectly by reflex action, after removal of the entire higher brain. Detailed analysis proves this whole reaction to be a chain of reflexes again essentially geotropic.

Following these researches we see, therefore, that it is less true to say that the higher animal under direction of its mind keeps itself right side up, than to say that the animal body by automatic mechanism is kept right side up. From the animal's point of view, as a sentient being, for it to be right side up to the world is, of course, for the world to be right side up to it. In other words, the body's automatism ensures that the mind looking, so to say, out from the body, finds the world right-side-up. By the Utrecht researches that relation is shown to be maintained by processes as non-mental as is digestive secretion of the bile. Hence, this right-side-upness being settled without mind, and indeed prior to mind, and naïve mind being, whatever else it is, utilitarian, the situation has not invited consideration from naïve mind. Mind has not needed, so to say, to think about a relation already existent and given it from the outset.

Prof. Magnus's researches enable us, therefore, to trace how, in the make-up of mind, right-side-upness of the world comes as an innate unargued datum, an immediate intuition, and therefore largely eludes mental analysis, there being no direct sense-experience of its origin or elemental processes, although confusion in mental space when its elements conflict. William James, with characteristic picturesqueness, wrote that our "prehistoric ancestors discovered the common-sense concepts," among them what he termed "one-space." With that we may set "world right-side-upness"; but as for dating its "discovery" to our prehistoric ancestors, it, as an immediate intuition, must date back not to the merely prehistoric but to the entirely prehuman.

Presentation of Medals.

The Copley Medal is awarded to Sir Edward Sharpey-Schafer. Sir Edward's work, extending from 1874 to the present time, has illuminated many parts of physiology, and the field of microscopical

anatomy no less. In 1894 he discovered, in conjunction with Dr. George Oliver, the remarkable effects of intravenous injection of extract of the adrenal gland, tracing their source to the small medullary portion of the gland. This research proved the starting point for a great volume of work, and was followed by somewhat similar work on another ductless gland, the pituitary, which opened a modern chapter of physiological knowledge of that organ, again with important consequences to medicine.

The Rumford Medal is awarded to Mr. C. V. Boys. Mr. Boys has advanced physical science by producing apparatus for accurate physical measurements and by making measurements of a high order of accuracy. He invented the first method for producing quartz fibres and investigated their elastic properties; he showed that they were practically free from fatigue, and demonstrated how admirably suited they were for the measurement of very small forces. He measured the extremely minute forces due to the mutual attraction of small masses, and he made a torsion balance of beautiful design for measuring the constant of gravitation. He took the first photographs of a bullet in flight and studied the wave disturbances produced by them, and has made a series of researches on soap bubbles and films. Recently he has developed a gas calorimeter which is the standard instrument prescribed by the gas referees for ascertaining the calorific value of the gas supplies of towns, work of special appeal in regard to a medal commemorative of Count Rumford.

A Royal Medal is awarded to Sir Dugald Clerk. In 1886, Sir Dugald described his experiments on the explosion of gaseous mixtures, providing data fundamental for the scientific development of internal-combustion engines. As chairman of the British Association Committee for investigation of gaseous explosions, he drew together workers concerned with the thermodynamics of internal-combustion engines who have contributed results of high importance. Sir Dugald himself investigated the effect of turbulence in a gas-engine cylinder and was successful in explaining the difference between the rate of combustion of the charge fired in a gas-engine cylinder in ordinary conditions of working, and the rate of combustion of the charge fired in a bomb. That to-day the internal-combustion engine is taking the place of steam power in smaller ships and in workshops as a prime mover of moderate power, and that to-day that engine renders possible the motor-car, the aeroplane and the submarine, is due largely to the scientific work of Sir Dugald Clerk.

A Royal Medal is awarded to Dr. Henry Hallett Dale. Working with successive collaborators, Dr. Dale showed that histamine, an amine derived from ergot, produces a condition resembling wound shock and toxæmic collapse. By analytic experiments he succeeded in establishing that histamine, while causing spasm of arterial and visceral muscle, conversely paralyses the active contraction of the capillary blood-vessels; and this analysis was reached at a time when the property of contractility of those vessels had not been generally recognised. He showed that their paralysis is the dominant feature in the shock and is responsible for a virtual break-down of the whole blood circulation. He has shown further that in histamine "shock" we have a paradigm for the shock effect of a large class of protein poisons, and also for the grave condition known in medicine as secondary surgical shock, toxæmic collapse, and anaphylactic shock.

The Davy Medal is awarded to Prof. A. G. Perkin. Prof. Perkin is distinguished for his researches on the natural organic colouring matters. During the course of his researches on luteolin, morin, apigenin, quercitrin and other flavone compounds, he discovered and investigated certain derivatives which such dyestuffs form with acids—substances which he was able to employ for determining the molecular weights of these colouring matters. His classical researches on natural indigo have left few questions unanswered as regards the chemical constitution and behaviour of this important product, and he was the first to show that one of the constituents—indirubin—played no part during the process of vat dyeing with this agent. He was also the first to prepare in large quantity crystalline indican—the essential glucoside of natural indigo—and to study its properties. More recently he has investigated other natural products, notably the colouring matter of cotton flowers, and has dealt with the formation and structure of the important vat-dyes derived from benzanthrone.

The Darwin Medal is awarded to Prof. T. H. Morgan. Prof. Morgan's studies on polarity, on fertilisation, and later on gynandromorphism and sex determination, mark distinct advances in knowledge. The discovery of two kinds of spermatozoa in phylloxera and observations on chromosomes in these and other insects helped to elucidate the nature of the determination of sex in parthenogenesis. Of late years he has devoted himself to the study of heredity in various animals, and especially in the fly, Drosophila. The results obtained by him and his collaborators have thrown light on the relation of the factors of heredity to the chromosomes, on sex-linked and sex-limited characters, and other difficult problems in heredity.

University of Leeds.

TRIBUTE TO PROF. A. SMITHELLS, C.M.G., F.R.S.

THE movement which was set on foot some time ago for signalising the distinguished services of Prof. Smithells to the University of Leeds, and in other directions, reached its culminating point on November 25, when a portrait of Prof. Smithells, painted by Mr. Fiddes Watt, A.R.S.A., was presented to the University at a ceremony held in the Great Hall. At the same time, it was announced that the fund had reached the sum of 2462*l.* 6*s.* 11*d.*, of which approximately one half had been contributed by the gas industry, to which Prof. Smithells had been able to render such distinguished service.

The proceedings were opened by the pro-chancellor of the University, Mr. E. George Arnold, who spoke in the warmest possible terms of what Prof. Smithells had done during his 38 years' tenure of the chair of chemistry not only as professor of that subject but also in connexion with the wider matters of policy which the University had had to face at the time of its foundation and in the years that followed.

Mr. Arthur Lupton, who was pro-chancellor of the University during most of the long period of Prof. Smithells' service, presented the portrait on behalf of the subscribers, who numbered more than 800. He was followed by Prof. J. W. Cobb, who supported Mr. Lupton in the presentation and spoke as an old student of Prof. Smithells and a colleague in the Senate and on the Board of Science and Technology. He pointed out that when it was decided to make Leeds a centre of university education, not merely was it that a new university was instituted but a new kind of university. Its distinguishing mark was that not only was science to have a place of honour, but that a Faculty of Technology was to be created

in the University to rank along with the other Faculties of Art, Science, and Medicine, and to live alongside them in the closest intimacy. To do this effectively required judgment, imagination, and particularly courage and the faculty of dealing wisely with men and affairs. Prof. Smithells had written and spoken on this subject but always impersonally. On this occasion it was only proper that prominence should be given to the personal aspect, and the dominating part played by Prof. Smithells in this work fully and freely acknowledged.

Further support came from Prof. B. M. Connal, speaking as an old Arts colleague, and from Mr. J. Ferguson Bell, the president of the Institution of Gas Engineers, who, speaking for the gas industry, acknowledged the great indebtedness which they felt to science in application to their industry and particularly to the work of Prof. Smithells and the University of Leeds.

The portrait was received by the vice-chancellor on behalf of the University.

Prof. Smithells then described how his scientific work on flames had brought him into contact with the gas industry and its problems, and acknowledged, in impressive terms, its generosity to the University and the honour now paid to him. Referring to his colleagues, past and present, he paid a tribute to the founders of the old Yorkshire College and the remarkable group of men of science—Green, Rucker, Thorpe, and Miall—who in the early years so successfully disseminated the right spirit in the young institution, which ensured its initial success and later progress. To the late Prof. L. C. Miall he expressed a special personal tribute and the belief that no man did more for the spirit of the College and University. Speaking of the scholarship to be founded with the funds subscribed, he had wondered for a moment whether unity of knowledge might not receive appropriate illustration by devoting it to some literary end, but the idea was no doubt somewhat fantastic in this connexion. After all, he believed in science and shared the conviction expressed by a great man of letters, Mr. Galsworthy, that the future of the race was in the hands of science. It was right and proper, therefore, that this scholarship should be devoted to its advancement. In complimenting Dr. Baillie on his appointment as vice-chancellor, he assured him of a generous welcome, and expressed a firm faith in the modern university.

It was announced that the Smithells Fund would allow, after payment of the portrait and incidental expenses, of the establishing of a scholarship bearing the name of Prof. Smithells, within the University, of approximately 100*l.* per annum.

The British Dirigible Programme.

THE decision to take up again the development of dirigibles in Great Britain has probably been influenced by the example of the United States.

The following table gives a basis of broad comparison with German craft:

Name.	Length.	Diam.	Volume.	Displacement.	Power.	Speed.	Length/Diam.
	m.	m.	cub. m.	tons.	k.w.	km./hr.	
R 101 .	220	39·9	143,000	165	7×430	115 est.	5·5
"Burney"	212	40·5	143,000	165	7×430	115 est.	5·25
ZR 3. .	203	28	70,000	81	5×300	140 max.	7·25
L 59 . .	226·5	23·9	68,500	79	5×180	131 max.	9·5
Bodensee	121	18·7	20,000	23	4×180	135 max.	6·45

German practice shows much greater ratios of length/diameter; in the case of the L 59, this was perhaps due to the greater ease with which existing airsheds can be increased in length than in height and width; but the *Bodensee*, a successful post-War commercial craft, and the ZR 3, the latest example of German design, were free from this restriction.

In passing from the ZR 3 to the R 101 and the "Burney" the volume and power are both doubled, so that with similar shapes there should be an increase in speed of about $2^{1/9}=1{\cdot}08$, or from 140 km./hr. to 151 km./hr., as compared with 115 km./hr., which is a heavy margin in estimating. The shapes are, however, very different.

Tests at the National Physical Laboratory on relatively minute models in the wind-tunnel indicate a "best" ratio of length/diam. between 4·5 and 6. Presumably the British designers are not relying solely on a very doubtful aerodynamical similarity, and it would be interesting to know the full size data on which they are departing so boldly from German practice.

The United States naturally hold for themselves the only supplies of helium, and the best method open to other nations for reducing fire risks is by installing heavy oil engines as is specified for the new British craft. The specification of "stainless" steel for the metal framework indicates a surprising advance in the design of members to resist local buckling in the very thin webs and flanges as compared with lighter and bulkier duralumin.

In a previous note (NATURE, October 11, p. 548), the useful life of a dirigible was estimated from German records as less than two serious voyages per month for eighteen months, excluding fire and war risks. It remains for time to show how far the ZR 3 in American hands, and the new British craft in British hands, will compete with this standard of performance set up by the Germans after more than twenty years' experience.

No doubt it is difficult for the authorities to neglect completely a potential weapon, even though the aeroplane has proved an almost perfect antidote. From this point of view alone, their decision is entirely defensible. The long delay in coming to it may well be explained by the formidable nature of the problem taken as a whole.

University and Educational Intelligence.

CAMBRIDGE.—The time having lapsed during which the University can suspend the Jacksonian professorship of natural philosophy, and no new scheme for it having been adopted by the University, the Vice-Chancellor has declared that the professorship is vacant. An election will take place on January 5 next.

Mr. F. Balfour Browne, Gonville and Caius College, has been appointed University lecturer in zoology.

LONDON.—The title of professor of anatomy in the University has been conferred on Mrs. M. F. Lucas Keene, in respect of her post as head of the Department of Anatomy at the London School of Medicine for Women. Prof. Lucas Keene was appointed lecturer in anatomy and embryology, with charge of the department, at the London School of Medicine for Women in 1919, and the title of reader in anatomy in the University was conferred on her in respect of this post in 1921.

A course of free public lectures on "The Anatomy and Physiology of the Sympathetic Innervation of the Striated Muscle" will be given at University College, at five o'clock on December 8, 10, and 12, by Prof. J. I. Hunter, of the University of Sydney. No tickets will be required.

Applications are invited for the chair of pathology at the London (Royal Free Hospital) School of Medicine for Women. Twelve copies of each appli-

cation should be received by, at latest, the first post of January 29 by the Academic Registrar, University of London, South Kensington, S.W.7.

APPLICATIONS are invited by University College, Nottingham, for a lectureship in psychology. The person appointed will take charge of the psychological laboratory and be expected to assist in the teaching of philosophy. Forms of application (returnable not later than December 10) can be obtained from the registrar.

A FULL-TIME male teacher of chemistry is required at the Northern Polytechnic Institute, Holloway, N.7, with a knowledge of the application of chemistry to the building and rubber trades. Candidates must be university graduates, preferably with honours degrees. Application forms are obtainable from the Secretary of the Institute.

IT is stated in the *Chemiker Zeitung* that two newly created professorships in the medical faculty of the University of Münster have been filled by the appointment of Dr. Heinrich Többen to the chair of forensic medicine, and of Dr. Hermann Freund, of Heidelberg, to the chair of pharmacology.

PROF. W. H. MOBERLY, professor of philosophy in the University of Birmingham, has been appointed principal of University College of the South-West, Exeter, in succession to Principal Hetherington, who is becoming professor of philosophy in the University of Glasgow.

THE Leeds University Calendar for 1924–25 refers to the jubilee celebrations which will take place during the week December 15-20. Fifty years have elapsed since Yorkshire College was established as a College of Science, and forty since it was united with the Leeds School of Medicine, founded in 1831. The College formed part of the Victoria University, Manchester, from 1887 to 1904, when the University of Leeds was established by Royal Charter. The new Calendar, unlike previous issues, gives no particulars of the staff.

THE *Educational Record*, published quarterly by the American Council on Education, gives in its July number an interesting series of reports on the various activities of the Council and its committees during the past year. Like the Standing Committee of Vice-Chancellors in Great Britain, it was formed under the stress of war-time conditions, and has steadily grown during the past six years in importance. It is now the most influential voluntary body for the promotion of the interests of education in the United States. Some idea of the scope of its work can be gathered from the following list of subjects dealt with by its several committees: educational finance, federal legislation, college and university personnel, foreign language teaching, Franco-American exchange, international educational relations, foreign travel and study, college standards. The Director classifies the Council's activities under five main headings—standards, personnel, national relations, international relations, and research. It is his special care to ensure that work done under each of these heads is guided so as to contribute most fully to the advancement of the work in progress under the other heads. One of the most important of the Council's enterprises is the "Division of College and University Personnel" created two years ago for compiling a perpetual register of college teachers, their academic careers and qualifications, for the whole of the United States.

THE annual meeting of the Geographical Association will be held on January 1-3 at the London School of Economics, and arrangements have been made for members to travel to the meeting at reduced railway fares. Prof. J. L. Myres will deliver his presidential address on "A Geographical View of the Historical Method in Ethnology" on January 2, and he will also broadcast a message on "Wayside Geography" on the previous evening. Included among the numerous illustrated lectures which will be given is one by Mr. R. U. Sayce, of the Department of Geography, Natal University College, on aspects of the human geography of Natal. On January 1, a discussion, to which all university teachers of geography are invited, will be opened by Prof. J. L. Myres on "Departmental Research Programmes," while on the next day there will be a symposium on the life of fiord people, at which Dr. A. Sommerfelt (Kristiania), Mr. Henry Balfour (Oxford), Mr. C. E. P. Brooks (Meteorological Office), and Mr. C. B. Fawcett (Leeds) will speak. January 3 is to be devoted to special sessions on the teaching of geography. The first discussion, on school geography, will be opened by Mr. S. W. Rider (Gowerton County School) and Capt. T. K. Mortimer Booth (Christ's Hospital). At midday, four simultaneous discussions will be held: on the beginnings of geography, the teaching of climate, home geography, and school geography clubs and journeys. The afternoon will be devoted to excursions to various parts of London, including a party under the leadership of Mrs. Ormsby to beat the bounds of the City of London. On the first two days of the meeting a publishers' exhibition of books and maps will be open. Further particulars of the meeting can be obtained from the secretary of the Association, 11 Marine Terrace, Aberystwyth.

"CONTINUITY" was the text of a speech by the president of the Board of Education at the annual dinner of the London Teachers' Association on November 29. He hoped that in the coming year careful surveys of the field of education would be made by local authorities with the view of framing comprehensive schemes of development. Such a scheme has just been drawn up by the West Riding Education Committee providing for new capital expenditure during the years 1926 to 1932 on sites, buildings, and equipment, of 1,000,000*l.* for elementary, 543,000*l.* for secondary, and 300,000*l.* for technical education, entailing maintenance charges of 270,000*l.* per annum. Among the improvements aimed at are: (1) the reduction in size of classes (at present 946 classes contain more than 50 and 1332 from 41 to 50 children each); partly by means of (2) Central Schools in which adequate provision, impossible under present conditions, will be made for (3) instruction in handicraft and domestic subjects; (4) increasing the proportion of attendance at secondary schools from 9·5 to 15 per thousand of the population; (5) to provide for technical and other forms of further education 84 new schools and 10 enlargements or replacements. Under the last-mentioned head are included not only technical schools in buildings provided for the purpose or used jointly as secondary or middle schools, but also technical classes with "facilities for practical work in Science, Manual Training, Cookery, History, Social Science, Pure Natural Science, Botany, Entomology, etc., that might suitably be incorporated in the buildings of a Central School or a Central Top for a group of elementary schools." The annual additional charge on the rates, assuming that the capital is to be borrowed, will, it is estimated, amount to 6*d.* in the pound on the basis of existing assessable values.

Early Science at the Royal Society.

December 6, 1677. Dr. Croune related, that Sir Peter Colleton had taken care to send several baroscopes to Barbados, in order to examine, whether they would be of any use for the foretelling the seasons and mutations of the weather as they are found to do in England especially concerning hurricanes.—The president inquiring what experiments were designed for the next meeting, Mr. Hooke undertook to have the hydrostatical experiment ready; as also a farther improvement of the microscope. It being late the Society rose, and waited on the president to his own house.

December 7, 1664. It being suggested, that there were several persons of the society, whose genius was very proper and inclined to improve the English tongue and particularly for philosophical purposes; it was voted that there be a committee for improving the English language; and that they meet at Sir Peter Wyche's lodgings in Gray's-Inn.

December 8, 1670. Monsr. Andreas Monceaux, a French gentleman and a great traveller, son to Monsr. Monceaux, counsellor to the most Christian King, and great audiencier of France was proposed candidate.

December 9, 1663. The experiment of trying the force of powder by weight in the new powder engine contrived by Mr. Hooke was made twice, but without success both times; once by reason that the barrel broke in pieces; the second time, because the cover of the barrel bent. It was referred to Mr. Hooke to think of a way to prevent the inconveniencies.

1667. Sir Anthony Morgan and Mr. Hoskyns reported concerning the legal validity of the obligation subscribed by the fellows of the society; that the statutes had already specified the penalty for non-observance, viz., expulsion; and that thereby other penalties were excluded.

1669. Mr. Hooke produced another specimen of staining with yellow, red, green, blue and purple colours; which he said would endure washing with warm water and soap.

1675. There was produced a manuscript of Mr. Newton, touching his theory of light and colours, containing partly an hypothesis to explain the properties of light, partly the principal phenomena of the various colours exhibited by thin plates or bubbles, esteemed by him to be of a more difficult consideration.

December 10, 1662. The experiment of purging water from air, to see whether it subsides, according to the Torricellian experiment was deferred till the next meeting, because the engine was not tight.—Dr. Croune brought in some account of the breaking of wires; the experiment whereof appearing as yet very uncertain, he was desired to prosecute the same by trying several wires of different matter, and the same size, to see, whether the proportion of toughness in different metals may be found.

1668. A letter of Dr. Wallis contained an answer to some queries of Mr. Neile, viz., 1. Whether quiescent matter have any resistance to motion. 2. Whether motion may pass out of one subject into another. 3. Whether no motion in the world perish. 4. Whether different motions meeting destroy one another. Ordered to be entered.

December 12, 1678. Mr. Povey presented to the Society for their library a small stitched book in 4to. containing an history of Chelsea College.—He presented likewise, the claw of a West India spider, very much resembling the claw of a lobster or crab; given him by the Lord Willoughby of Parham as a present remedy against the tooth-ache.

Societies and Academies.

LONDON.

Optical Society, November 13.—T. **Smith**: (1) The theory of neutralisation. According to the new theory which is propounded, the test should be made with the lenses midway between the test object and the observer's eye, and the connexion between the vertex powers of the lenses when neutralisation is exact involves the distance of the test object and the order in which the lenses are placed. The simple law of the zero sum for the vertex powers is attained with simple accuracy as a mean result, the combination of high-powered lenses of equal and opposite vertex powers appearing as a positive lens from one side and negative from the other. The theory leads to the suggestion that in practice plano-lenses should be tested with their plane, not their curved, surfaces in contact. (2) The back vertex power of a combination of lenses. The general relations between the constants of a compound instrument and those of its components are obtained when the imagery is collinear. From these relations the expression for the vertex power of a compound instrument is built up in the form convenient for application in spectacle and other calculations.—R. **Kingslake**: A new type of nephelometer. The instrument provides an accurate optical method of measuring a minute amount of precipitate by means of the turbidity it produces in solution. Light is passed into the end of a tube containing the solution, and the intensity of the scattered light is measured by a special form of wedge-photometer.—A. **Pollard**: A note on nephelometry. The nephelometer described above is capable of measuring such minute quantities as the amounts of the oxides of nitrogen evolved from explosives in unit time under normal temperature and pressure.

Physical Society, November 14.—W. H. **Eccles** and C. F. A. **Wagstaffe**: An electrical method of producing vowel sounds and its application to wireless telegraphy. Apparatus has been devised to test a proposed method of communication in which the electric waves transmitted could produce easily recognisable chords at a suitably equipped receiving station. It was thought that chords would be more easily recognised than simple tones, and that vowel sounds would be the most easily recognised of chords. The ideal aimed at in this method of communication is that an operator at one side of the ocean should converse with an operator at the other side by means of a language made up of vowel sounds (somewhat like the Hawaiian language), the sounds being produced by pressing keys. Any ordinary language could be converted immediately into this telegraphic language by a code wherein each consonant was represented by a definite pair of vowel sounds.—D. W. **Dye** and L. **Hartshorn**: The dielectric properties of mica. Practically all samples of muscovite (potassium mica) have the same dielectric constant, the most probable value being 7·0. The presence of inclusions has no great effect on this value. The samples of phlogopite (magnesium mica)—*i.e.* the amber micas—have rather lower dielectric constants, about 6·0 for normal amber mica, and 5·0 for the silver amber variety. For the clear micas (muscovite) the power factor may be so low as 0·0003, and possibly less. The effect of inclusions is to increase it considerably. The power factor of the amber micas is greater than that of the muscovite variety—about 0·02 for the clear amber and 0·05 for the silver amber variety. The samples were all about 8 cm. square and 0·1 mm. thick, and the measurements were all made on the Carey Foster bridge at a frequency of 800 cycles per

second.—L. **Simons**: The X-ray emission of electrons from metal films, with special reference to the region of the absorption limit. Barkla and Miss Dallas have shown how the total energy of the β-rays from silver (as measured by the ionisation produced in H_2) varies with wave-length as the region of the K absorption limit is crossed. The author has now determined directly the aggregate number of β-rays of all types emitted over the same range; no selective change in the average energy occurs when the K fluorescent spectrum is excited. This is brought about by a re-grouping amongst the numbers and energies of the β-rays constituents, together with the addition of the K group of minimum individual energy. The experimental work has necessitated the separation of the β-rays from the secondary effects they produce, the chief of which is the production of δ-rays of very low energy. The δ-rays seem to be impact electrons the most frequent energy of which is little greater than 3·5 volts; this seems to be independent of the wave-length producing them, and of the substance from which they come. There are indications that they are influenced, at the moment of their departure from the surface, by the scattered X-rays.

PARIS.

Academy of Sciences, November 10.—M. Guillaume Bigourdan in the chair.—A. **Lacroix**: Remarks on the dissogenites, with reference to Colorado evergreenite.—G. **Bigourdan**: Observation of the occultation of Mars by the moon on November 5, 1924. The times of the second and fourth contacts are given. The sky was clear, but the atmospheric conditions were not good.—Armand **Cahen**: Developments proceeding according to f functions indefinitely superposed and arranged in descending chain.—A. **Bloch**: Functions taking several times the values 0 and 1 in a circle.—E. F. **Collingwood**: Some theorems of M. R. Nevanlinna.—Arnaud **Denjoy**: The singularities of series of rational fractions.—M. **Lyot**: The polarisation of the planet Saturn. It has been shown in earlier communications that light from the moon, Mars, and Mercury is polarised; the polarisation caused by Venus appears to be due to clouds, whilst that of Jupiter is partly due to clouds and partly to an atmosphere. Observations on Saturn made in May and June 1922, April, May, and June 1923 and 1924. The ring and the planet showed different polarisation phenomena, and the results are shown separately on a graphical representation of the results.— — **Giacobini** and — **Fatou**: Observations of Baade's planet, made at the Paris Observatory. Four positions are given on November 6, 7, and 8, together with the positions of the comparison stars. At present this planet is of 9·3 magnitude.—Ferdinando **Gazzoni**: An attempt at the quantitative estimation of thorium-X. In the presence of thorium, after precipitation by hydrogen peroxide, the filtrate contains thorium-X and its active deposit: in the presence of aluminium, after precipitation by ammonia, only thorium-X is found in the filtrate.—Paul **Pascal**: The definition and preparation of the hexametaphosphates. On the basis of cryoscopic and electrical conductivity measurements, and in view of the existence of a sodium lead salt ($Pb.Na_4(PO_3)_6)_2$, Graham's salt is regarded as a complex hexametaphosphate of the constitution $Na_2(Na_4(PO_3)_6)$.—E. **Burlot**: The determination of the theoretical energy and the co-volume of explosives.—Henry **Le Chatelier**: Observations on the preceding communication of E. Burlot. In experiments made forty years ago (with Mallard) the authors calculated some specific heats. The experiments in the preceding paper show the necessity of modifying these figures, which were probably 10 per cent. too high.—Claude **Fromageot** and René **Wurmser**: The comparative adsorption of some organic acids and their sodium salts. The adsorption by charcoal of formic, acetic, propionic, oxalic, succinic, citric and pyruvic acids from aqueous solutions was determined and compared with the adsorption of their sodium salts from solutions of the same concentration. No simple relation was found between the adsorption of the different groups and the dissociation constant of the acids to which they belonged. The salts are always less adsorbed than the corresponding acids.—L. J. **Simon**: The conditions of application of the technique for the estimation of carbon by the argentosulphochromic method. Experiments showing the relation between the amount of silver bichromate used in the analysis and the time required for complete combustion are recorded.— — **Tiffeneau**, A. **Orékhoff**, and Mlle. J. **Levy**: The isomerisation of the ethylene oxides with migration. The mechanism of molecular transpositions. Trisubstituted ethylene oxides of the type $Ar.CH.C(RR)$ can be isomerised under the influence of heat, giving rise to the corresponding aldehydes $Ar.C(RR').CHO$. It is certain that in this case the migration of the aromatic group cannot be the initial change.—Marcel **Delépine**: The structural relations between the pinenes and the terpineols or the limonenes derived from them.—J. **Barthoux**: The pyrites of Maïdan-Peck (Serbia).—Mme. A. **Hée**: The frequency of earthquakes in Algeria during the ten years 1911-1920.—Marcel **Mirande**: The optical properties of the sterinoplasts and of the phytosterin of the bulbs of the white lily.—René **Souèges**: The embryogeny of the Euphorbiaceæ. The development of the embryo in *Euphorbia Esula*.—Marc **Bridel**: The hydrolysis of monotropitine by a ferment. The production of primeverose. The products of hydrolysis of monotropitine (extracted from *Betula lenta*) by an enzyme extracted from *Monotropa hypopitys* were methyl salicylate and the reducing sugar, primeverose. The latter was obtained crystallised and was proved to be identical with the primeverose obtained from gentiacauline and from the glucosides of *Primula officinalis*.—J. **Beauverie**: The germination of the uredospores of the rust of wheat.—E. **Leblanc**: The orbital muscles of reptiles. Study of the muscles in *Chameleo vulgaris*.—M. **Javillier**, P. **Bauer**, and Mlle. S. **Levy-Lajeunesse**: Attempts at the identification of the factor A. The factor A and phytol. The unsaponifiable fraction of chlorophyll, consisting mainly of phytol, has many properties in common with the liposoluble factor A, but experiments on rats proved that phytol has not the action of factor A.

COPENHAGEN.

Royal Danish Academy of Science and Letters, October 17.—C. **Wesenberg-Lund**: Contributions to the anatomy and biology of the genus Zoothamnium. The biology and anatomy of Z. *geniculatum* has been studied during two years. Special attention has been paid to the so-called macrogonidia, their origin and their significance for the formation of new colonies.

October 31.—Johannes **Fibiger**: Vilhelm Ellermann. His life and scientific work.—Niels **Nielsen**: Note on Lagrange's series. The name of Bürmann has been given to some series of Lagrange, but the supposed memoir of Bürmann does not exist. Research on a new series of Lagrange.

VIENNA.

Academy of Sciences, June 12.—F. **Werner**: Scientific results of the Treitl bequest zoological expedition to the Anglo-Egyptian Sudan, Kordofan, 1914. Odonata, compiled by F. Ris, including descriptions of two new species.—H. **Spandl**: Freshwater amphipodes, especially those of the Baikal and Caspian Seas, and the relation of the Caspian Sea fauna to that of the Arctic and Baltic.—V. **Brehm**: Descriptions of new Entomostraca from the Handel-Mazzetti expedition to China.—E. **Dittler** and A. **Köhler**: Experiments on potassium-sodium felspars. Perthite was heated at temperatures below the melting-points of its components. Thin sections about 0·02 mm. in thickness were used; an alteration of optical constants as seen through the microscope proved diffusion in the solid state. An electrical resistance furnace allowed a temperature of about 1000° C. to be maintained for 500 hours. Albite and orthoclase can diffuse into each other forming mixed crystals.

June 20.—F. **Kerner-Marilaun**: The solar-climatic temperatures of antiquity.—H. **Handel-Mazzetti**: New Chinese plants described, including species and varieties of Juniperus, Camellia, Schima, Lobelia, Leontopodium.—L. **Kölbl**: Tectonic of the granite peaks in the High Tauern.

June 26.—R. **Kremann** and R. Gruber-**Rehenburg**: Electrolytic conduction in fused metal alloys, copper-zinc, copper-tin, copper-silver, and copper-aluminium.—R. **Kremann** and O. **Benda**: The electrolysis of silver-lead alloys.—R. **Kremann** and H. **Drazel**: On the influence of substitution in the components of binary solution equilibria. Equilibrium diagrams for benzhydrol with phenols and amines.—E. **Müller**: Calculating with fold-products as applied to three-dimensional objects of the second order.

July 3.—E. **Lohr**: Continuum theory of Röntgen ray propagation in crystals.—H. **Handel-Mazzetti**: New Chinese plants.—I. **Pia**: The diplopores in the Trias of Southern Dalmatia.—E. **Hofmann**: Plant remains from the lake-dwellings of Mondsee.

July 10.—E. **Philippi** and R. **Seka**: On the dinaphth-anthracene series. VI. Condensation of pyromellithic acid anhydride with decaline and tetraline. VII. Sulphonation of di-naphth-anthracene-di-chinon. VIII. Substituted derivatives of pyromellithic acid. Some aliphatic polycarbon acids.—J. **Korczyn**: On the irregularities in the β-radiation of freshly crystallised uranyl nitrate.—G. **Ortner** and H. **Pettersson**: On the preparation of radium C II.—G. **Kirsch** and H. **Pettersson**: On the disintegration of atoms by α-rays (II.). A method for observing atomic fragments of short range.—H. **Pettersson**: On the disintegration of atoms by α-rays (III.). The disintegration of carbon. Bombardment by α-radiation gives H- and α-particles, the latter with a range of about 10·5 cm. The ranges of the H-particles at right angles to, and in the direction of, the primary radiation were 16 cm. and 8 cm. The results were in agreement with an explosive mechanism for atomic disintegration.—G. **Kirsch**: On the disintegration of atoms by α-rays (IV.). Disintegration of nitrogen and oxygen; helium a product. When fast α-rays traverse nitrogen, both H-particles and secondary α-rays arise. α-particles were also obtained from oxygen. The collisions of swift α-particles with light atoms yield hydrogen and helium as disintegration products.—H. **Handel-Mazzetti**: New Chinese plants. The descriptions of new Chinese Primulas collected by the Handel-Mazzetti expedition are continued. Six new primulas are described, some from 10,000 feet and higher in the mountains of the provinces Yunnan and Setschwan.—F. M. **Exner**: Monthly anomalies of atmospheric temperature and pressure on the earth; correlation of the pressure in Iceland with the pressure in other places.—O. **Dafert** and J. **Höfinger**: Chemical investigations of the deposits from the Dragon Cave near Mixnitz in Styria.—R. **Kremann** and J. **Dellacher**: Electrolytic conduction in fused metal alloys (IX.), tin-aluminium alloys.—M. **Kohn** and M. **Weissberg**: On *m*-bromophenol (VII.).—G. **Weissenberger** and L. **Piatti**: Molecular compounds of phenols (II.). The behaviour of cresols with aromatic hydrocarbons.—G. **Weissenberger** and H. **Waldmann**: On absorption from viscous fluids by charcoal.—R. **Seka**: On 8-amido-chinolin and derivatives.—F. **Kautsky**: The more recent folding in the eastern Alps and its expression in the gravity diagram.—L. **Moser** and R. **Lessnig**: The identification and separation of rare metals from other metals (V.). The separation of zirconium and hafnium from titanium, cerium, and thorium.—A. **Brukl**: The preparation of metallic tellurides from tellurium hydride and metallic salt solutions.

October 9.—H. **Kurtz**: A revision of the genera Lernæogiraffa and Doryphorus, parasitic copepods inhabiting the gills of a fish Heterotis in the river Nile.—F. **Querner**: The head and mouth parts of the African fly, *Diopsis apicalis*.

October 16.—A. **Tauber**: Some properties of algebraic functions.—E. **Dittler** and A. **Köhler**: The behaviour of felspars at high temperatures. Continued investigations of perthite.—G. **Weissenberger** and F. **Schuster**: Molecular compounds of phenols (III.). The behaviour of binary systems with hydrated phenols.—A. **Kailan** and H. **Raupenstrauch**: The esterification of fatty acids in glycerin, with a formula for the coefficient of velocity.—**F. Hochstetter**: On cases of total absence of septum pellucidum in man.

WASHINGTON.

National Academy of Sciences (Proc. Vol. 10, No. 9, September).—H. **Bateman** and P. **Ehrenfest**: The derivation of electromagnetic fields from a basic wave-function.—Alice H. **Armstrong**, W. **Duane** and W. W. **Stifler**: The influence on secondary X-ray spectra of placing the tube and radiator in a box. The X-ray tube and secondary radiator were placed inside a lead-lined wooden box, the back of which could be removed. Evidence was obtained of scattered radiation due to the Kα doublet of the molybdenum, but on removing the back of the box the form of the spectrum changed. It is suggested that the secondary and tertiary radiation inside the box may mask completely the effect of the secondary radiator under examination.—S. K. **Allison**, G. L. **Clark** and W. **Duane**: The influence on secondary X-ray spectra of placing the tube and radiator in a box. In these experiments a wooden box was used. Radiation with increased wave-length was obtained, agreeing with Compton's observations and also with the suggested tertiary radiation, but of carbon and oxygen. Removing the secondary radiator (a plate of sulphur), but retaining the wooden box, decreased the intensity of the spectrum without changing its character. If the box was removed and the secondary radiator retained, the character of the spectra changed.—B. **Davis** and R. von **Nardroff**: Further experiments on the refraction of X-rays in pyrites. In earlier experiments the characteristic K radiation of molybdenum was used; the K characteristic radiation from copper is now employed and as before (NATURE, April 26, p. 627) the results are in good accord with figures derived from the Lorentz dispersion formula. This formula seems to be valid for X-radiation.—K. K. **Smith** and L. I. **Bockstahler**:

An improved method of measuring the specific heats of metals at high temperature. A positively charged molybdenum cylinder surrounds a tungsten filament which acts as a thermionic emitter, and the whole is heated in a furnace. The changes in the thermionic current are measured by an oscillograph. The specific heat of tungsten at 2375°-2475° K is 0·045 cal. per gm. and the atomic heat 8·3 cal. per gram-atom.—C. E. **St. John** and H. D. **Babcock**: Note on the pressure and currents in the sun's atmosphere. Gathering up the observations of different workers during the past few years, a chart is constructed showing a scheme for the distribution of factors in the sun's atmosphere according to level.—C. E. **St. John** and W. S. **Adams**: Convection currents in stellar atmospheres. High dispersion spectrograms of Sirius, Procyon, Arcturus and the sun show close agreement between the differences enhanced minus arc lines and high- minus low-level lines, both differences being apparently due to variation in convection currents with level. Convection currents seem to increase with temperature. The pressures in the atmospheres of all these stars are low and of the same order.—E. B. **Wilson** and W. J. **Luyten**: A statistical discussion of sets of precise astronomical measurements (III.); masses of the stars. The distribution of the logarithm of the mass of the stars is very close to normal—closer than might be expected from the meagre data. Systems with unusually big masses are not included.—T. R. **Hogness** and E. G. **Lunn**: The ionisation potentials of hydrogen as interpreted by positive ray analysis. Hydrogen is ionised by impact electrons from a tungsten filament, and the positive ions are drawn into a magnetic field where they are analysed. Three positive ions were found, H^+, H_2^+ and H_3^+, the H_2^+ ions predominating; no negative ions were detected. To determine the ionisation potentials, the voltage of the impact electrons was decreased by steps from a maximum until no ions were detected. The values obtained were: H^+, 16·6 volts; H_2^+, 15·7 volts; H_3^+, 16·7 volts.—G. E. M. **Jauncey** and H. E. **Stauss**: The polarising angle for X-rays scattered by paraffin. A shift of the polarising angle was observed according qualitatively with Jauncey's equations for a corpuscular quantum theory of the scattering of polarised X-rays.—R. G. **Dickinson**: The combination of hydrogen and oxygen in the presence of activated mercury. Hydrogen and oxygen in a quartz reaction tube were exposed to a blast of air from a mercury lamp; the pressure decreased steadily, apparently owing to the formation of water.

Official Publications Received.

Smithsonian Miscellaneous Collections. Vol. 75, No. 2: Cambrian Geology and Paleontology, V. No. 2: Cambrian and Lower Ozarkian Trilobites. By Charles D. Walcott. (Publication 2788.) Pp. 53-66. Vol. 76, No. 11: The Freshfield Glacier, Canadian Rockies. By Howard Palmer. (Publication 2757.) Pp. 16+9 plates. Vol. 77, No. 1: A Chapter in the History of Zoological Nomenclature. By Leonhard Steineger. (Publication 2789.) Pp. 21. (Washington: Smithsonian Institution.)

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 3: An Evaluation of Kindergarten-Primary Courses of Study in Teacher-Training Institutions. By Nina C. Vandewalker. Pp. iii+44. (Washington: Government Printing Office.) 5 cents.

Annuaire de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, 1924. 90e année. Pp. 450+9 planches. (Bruxelles: Maurice Lamertin.) n.p.

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 489: Primary Radio-frequency Standardization by Use of the Cathode-Ray Oscillograph. By Grace Hazen and Frieda Kenyon. Pp. 445-461. (Washington: Government Printing Office.) 10 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 244: Tides; a Manual of the Harmonic Analysis and Prediction of Tides. By Paul Schureman. (Special Publication No. 98.) Pp. x+416+9 plates. (Washington: Government Printing Office.) 1 dollar.

Bulletin of the National Research Council. Vol. 8, Part 5, No. 47: Classified List of Published Bibliographies in Physics, 1910-1922. Compiled for Research Information Service by Karl K. Darrow. Pp. v+102. (Washington: National Academy of Sciences.) 2 dollars.

Journal de la Société des Américanistes de Paris. (Reconnue d'utilité publique.) Nouvelle Série, Tome 16. Pp. xxx+552. (Paris: 61 rue de Buffon.)

Proceedings of the Royal Society of Edinburgh, Session 1923-1924. Vol. 44, Part 3, No. 22: The Theory of Circulants from 1800 to 1920. By Sir Thomas Muir. Pp. 218-241. 2s. Vol. 44, Part 3, No. 23: On a Class of Partial Differential Equations. By Dr. E. L. Ince. Pp. 242-247. 9d. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Leeds University. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing, during the Session 1923-24. Pp. 16. (Leeds.)

Memoirs of the Archæological Survey of India. No. 18: Hindu Astronomy. By G. R. Kaye. Pp. v+134. (Calcutta: Government of India Central Publication Branch.) 3 rupees; 4s. 8d.

The Royal Technical College, Glasgow. Annual Report on the One Hundred and Twenty-eighth Session adopted at the Annual Meeting of Governors held on the 21st October 1924. Pp. 79. (Glasgow.)

Suomen Geodeettisen Laitoksen Julkaisuja: Veröffentlichungen des Finnischen Geodätischen Institutes. No. 3: Die Beobachtungsergebnisse der Südfinnischen Triangulation in den Jahren 1920-1923. Pp. iii+235. No. 4: Untersuchungen über Schwerkraft und Isostasie. Von W. Heiskanen. Pp. iv+96. (Helsinki.)

Mysore Government: Meteorological Department. Report on Rainfall Registration in Mysore for 1923. By C. Seshachar. Pp. xvii+35+2 plates+2 maps. (Bangalore: Government Press.)

Memoirs of the Department of Agriculture in India. Entomological Series, Vol. 8, Nos. 5, 6, 7, 8 and 9. No. 5: Papers on Indian Tabanidæ; i. A Practical and Simple Method for rearing Tabanid larvæ; ii. The Number of Moults in Tabanid larvæ; iii. The Life History of *Tabanus crassus*, Walker, and the Identity of the Female of the Species; by P. V. Isaac. No. 6: Two Drosophilidæ from Coimbatore; and No. 7: A New Aphidiphagous Fly; by J. R. Malloch. No. 8: Notes on Indian Odonata in the Pusa Collection; by Major F. C. Fraser. No. 9: On New and Old Oriental Cicindelidæ; by Dr. Walther Horn. Pp. 53-91. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 1.4 rupees; 2s.

Publications of the South African Institute for Medical Research. No. 17: The Value of the Konimeter; being an Investigation into the Methods and Results of Dust-Sampling as at present practised in the Mines of the Witwatersrand. By A. Mavrogordato, with the Collaboration of J. Boyd, J. Innes, E. MacEwen, A. Pulford, L. G. Ray, G. D. Maynard, J. Moir, E. Cluver. Pp. 71+11 plates. (Johannesburg.) 5s.

Union of South Africa: Department of Agriculture. Science Bulletin No. 30 (Division of Chemistry Series No. 31): An Investigation into some Physical and Chemical Changes occurring in Grapes during Ripening. By P. R. v. d. R. Copeman. Pp. 38. (Pretoria: Government Printing and Stationery Office.) 3d.

Institut International d'Agriculture. Service de la statistique générale. Annuaire International de statistique agricole, 1923: International Yearbook of Agricultural Statistics for 1923. Pp. xcv+471. (Rome.) 30 francs; 8s.

Animal Breeding Research Department, The University, Edinburgh. Report of the Director for the Period from 1st July 1923 to 31st March 1924. Pp. 12. (Edinburgh.)

U.S. Department of Agriculture: Weather Bureau. Monthly Weather Review Supplement No. 24: West Indian Hurricanes and other Tropical Cyclones of the North Atlantic Ocean. By Charles L. Mitchell. Pp. iii+47+11 plates. (Washington: Government Printing Office.) 25 cents.

Proceedings of the Cambridge Philosophical Society. Biological Sciences. Vol. 1, No. 3, October. Pp. 139-218. (Cambridge: At the University Press.) 12s. 6d. net.

Bergens Museum. Aarsberetning, 1923-1924. Pp. 82. (Bergen: A/S John Griegs Boktryckkeri.)

Bergens Museum Aarbok, 1923-1924. Hefte 1. Naturvidenskabelig Række. Pp. 166. Hefte 2. Naturvidenskabelig Række. Pp. 262. (Bergen: A/S John Griegs Boktryckkeri.)

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, No. 27: Fossil Plants of the Calamopitys Type, from the Carboniferous Rocks of Scotland. By D. H. Scott. Pp. 569-596+6 plates. 6s. Vol. 53, Part 3, No. 28: On the Presence of Tetrads of Resistant Spores in the Tissue of *Sporocarpon furcatum* Dawson from the Upper Devonian of America. By Dr. R. Kidston and Dr. W. H. Lang. Pp. 597-601+1 plate. 1s. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

Diary of Societies.

SATURDAY, DECEMBER 6.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10 A.M.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—E. W. H. Piper: Durham Cathedral (Lecture).

INSTITUTE OF BRITISH FOUNDRYMEN (at Chamber of Commerce, Birmingham), at 4.—D. Wilkinson: Malleable Iron.

MONDAY, DECEMBER 8.

ROYAL IRISH ACADEMY, at 4.15.

VICTORIA INSTITUTE, at 4.30.—Prof. T. G. Pinches: The Worship of Idols in Assyrian History in Relation to Bible References.

CAMBRIDGE PHILOSOPHICAL SOCIETY (at Cavendish Laboratory), at 4.30.—C. T. R. Wilson and Prof. G. I. Taylor: The Bursting of Soap-bubbles in a Uniform Electric Field.—Prof. E. A. Milne: Dissociative Equilibrium in an External Field of Force.—Dr. T. M. Cherry: Some Examples of Trajectories Defined by Differential Equations of a Generalised Dynamical Type.—J. Brill: Note on the Lorentz Group.—E. H. Neville: Note on the Harmonic Conic.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—D. Fairweather: The Electrolysis of Salts of Alkyloxyacids.—W. West and E. B. Ludlam: The Ionisation of Iodine Vapour by Ultra-violet Light.—W. O. Kermack and W. T. H. Williamson: The Stability of Suspensions, I. The Rate of Precipitation of Kaolin Suspensions by Salts at Varying Hydrogen Ion Concentrations.—P. MacCallum and W. O. Kermack: The Influence of Gelatin on the Stability of a Colloidal Solution of Cholesterol, and on the Charge of the Particles.—W. O. Kermack and C. I. B. Voge: The Action of Salts with Multivalent Cations on Colloidal Solutions of Gold and Gum Benzoin.—A. O. Curle: Obituary Notice of the Rt. Hon. Lord Abercromby.—Dr. A. Lauder: Obituary Notice of Sir J. J. Dobbie.

BIOCHEMICAL SOCIETY (at Imperial College of Science and Technology), at 5.—E. Watchorn: The Magnesium of Human Serum.—M. E. Robinson and R. A. McCance: The Oxidation of Amino Acids by Fungus Tyrosinase.—H. W. Buston, H. N. Mukherjee, and S. B. Schryver: The Isolation of a Hydrolysis Product of the Proteins, hitherto undescribed.—H. Martin and S. B. Schryver: Some Transformations of Casein.—Dorothy Griffiths and S. B. Schryver: The Separation of the Proteins of Egg-white in an Electrical Field.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—A. V. Williamson: The Irrigation of the Indo-Gangetic Plain.

SOCIETY OF ENGINEERS (at 17 Victoria Street, S.W.), at 6.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—G. M. Clark and others: Discussion on the Pretoria Power Station.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—S. E. Flack: Ships' Propellers.

ROYAL SOCIETY OF ARTS, at 8.—Dr. L. C. Martin: Modern Colour Problems (III.) (Cantor Lectures).

SURVEYORS' INSTITUTION, at 8.

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. G. Graham, Prof. H. Maclean, and others: Discussion on The Present Position of the Treatment of Diabetes by Insulin.

BIOCHEMICAL SOCIETY (at Imperial College of Science).

TUESDAY, DECEMBER 9.

FARADAY SOCIETY (at Chemical Society), at 4.30.—Discussion on Base Exchange in Soils. Chairman: Sir Daniel Hall.—Dr. D. J. Hissink: Base Exchange in Soils.—Prof. N. M. Comber: The Rôle of the Electronegative Ions in the Reaction between Soils and Electrolytes.—H. J. Page and W. Williams: Studies on Base Exchange in Rothamsted Soils.—Prof. G. W. Robinson and R. Williams: Base Exchange in Relation to Soil Acidity.—S. J. Saint: The Relation between the P_H Value, the Lime Requirement, and the Thiocyanate Colour of Soils.—E. A. Fisher: Some Secondary Aspects of Base Exchange in Soils.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 4.30.—Prof. W. E. Dixon and Dr. F. H. A. Marshall: The Influence of the Ovary on Parturition.

ROYAL PHOTOGRAPHIC SOCIETY (Scientific and Technical Group), at 6.—Conference on the Standardisation of Plate Testing Methods.—The Light Source, Primary and Secondary. Spectral composition of the light source with special reference to colour sensitive plates; daylight correction filters, etc. Opening paper by J. W. T. Walsh.—The Exposure Mechanism. (*a*) Intermittent or continuous exposure; (*b*) Relative merits of wedge and sector wheel; (*c*) Other methods. Opening paper by S. O. Rawling.—Development. (*a*) Methods of development; (*b*) Effect of varying composition of the developer with the same emulsion; (*c*) Effects of temperature variation; (*d*) A standard developer. Opening paper by Dr. W. Clark.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. C. M. MacLagan: The Sliding Cylinder, Double-acting, Two-cycle Diesel Engine.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Centre) (at Town Hall, Leicester) at 6.45.—T. Hall: Domestic Applications of Electricity.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 7.15.—D. R. Nanji and W. S. Shaw: The Rôle of Silica in Plant Growth, its Assimilation and Physiological Relation to Phosphoric Acid.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—T. Martin: The Microscope in the Study of Alloys.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Meeting) (at Coventry).

SOCIETY OF DYERS AND COLOURISTS (Leeds Junior Branch) (at Leeds).—P. G. Marshall: The Tinctorial and Antiseptic Properties of Certain Types of Quinoline Dyestuffs.

INSTITUTION OF MECHANICAL ENGINEERS (Swansea Section) (at Swansea).

WEDNESDAY, DECEMBER 10.

ROYAL SOCIETY OF ARTS, at 5.—N. Thomson: Colombia as a Field for Development.

ROYAL SOCIETY OF MEDICINE (Otology, Laryngology, Medicine, Neurology Sections), at 5.—Dr. H. Thursfield, Sir William Milligan, Dr. W. Drought and Dr. J. G. Greenfield, W. M. Mollison, and others: Discussion on the Causes, Early Recognition, and Treatment of Non-tubercular Meningitis.

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 7.—E. Latham: Suitable Fendering for Tidal Berths.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-on-Tyne), at 7.—R. J. Welsh: Some Factors affecting Vacuum in Surface Condensers.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, W.C.), at 8.—Miss Eleanor F. Rathbone: Family Endowment and Birth Control.

INSTITUTION OF CHEMICAL ENGINEERS (at Institution of Mechanical Engineers), at 8.—A. J. V. Underwood: The Natural Soda Deposits of East Africa.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Centre) (Informal Meeting, at Manchester).

THURSDAY, DECEMBER 11.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Capt. H. Riall Sankey: Standard of Comparison in connexion with the Thermal Efficiency of Steam Engines.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.

INSTITUTE OF CHEMISTRY (jointly with Society of Chemical Industry) (at 36 York Place, Edinburgh), at 7.30.—Lt.-Col. W. G. Liston: Fumigation with Hydrogen Cyanide.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—A. G. Norris and W. H. T. Swire: Industrial Power Supply, a Comparison of Electrical and other Methods of Driving Industrial Machinery.

INSTITUTE OF METALS (London Local Section, Joint Meeting with Institution of British Foundrymen) (at Institute of Marine Engineers), at 7.30.—F. W. Rowe: Present Problems and Developments in Engineering Bronze Foundry Practice.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—J. E. Barnard: Some Problems in Medical Microscopy.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre) (at Trinity College, Dublin), at 7.45.

ROYAL SOCIETY OF ARTS, at 8.—Senatore G. Marconi: Radio Communications (Inaugural Address).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.15.—Prof. W. E. Dixon, Sir Havelock Charles, Sir William Collins, and Dr. Arthur Powell: Discussion on Some Clinical and Scientific Aspects of Drug Addiction in the Tropics.

INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Section) (at Birmingham).—Vice-Adml. Sir George G. Goodwin: The Trend of Development of Marine Propelling Machinery (Thomas Hawksley Lecture).

FRIDAY, DECEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Dr. J. Lunt: Large Line-displacements in the Spectra of Germanium and Chlorine under Different Conditions of Temperature.—Prof. E. A. Milne: The Equilibrium of the Calcium Chromosphere.—T. Allison: Squaring-on Newtonian Mirrors.—S. D. Tscherny: Occultation of B.D. −18°·6078 by Mars observed 1924, September 5, at the Astronomical Observatory, Kiew.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Capt. A. Egerton: Numerical Values of Chemical Constants and Frequencies of the Elements.—J. H. Powell: The Sensibility of Circular Diaphragms for the Reception of Sounds in Water.—A. Campbell, with Demonstration by W. H. Lawes: A Direct-reading Frequency Meter of Long Range.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. Cheese: A Winter Holiday in Greece.

INSTITUTE OF METALS (Swansea Local Section) (at University College, Swansea), at 7.15.—F. Hill and others: Discussion on the Design of Furnaces for Annealing and Heat Treatment.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—H. G. Bouly: Fluid Transmission Gears.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-on-Tyne), at 7.30.—S. B. Freeman: Fuel Oil for Marine Internal-Combustion and Steam Engines.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—O. S. Hillman, E. Apperly, and others: Discussion on Splanchnic Analgesia with Record of Cases.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Section).—Prof. G. F. Charnock: Some Fallacies concerning Invention.

SATURDAY, DECEMBER 13.

BRITISH PSYCHOLOGICAL SOCIETY (Annual General Meeting) (at King's College), at 3.15.—Dr. C. S. Myers: A New Theory of Sensory Adaptation.—Prof. C. G. Seligman: The Psychology of the Unconscious in Relation to Anthropology.

PHYSIOLOGICAL SOCIETY (at Middlesex Hospital).

PUBLIC LECTURES.

SATURDAY, DECEMBER 6.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: The Eggs of Animals.

TUESDAY, DECEMBER 9.

KING'S COLLEGE, at 5.30.—M. Kaye: F. H. Bradley—The Passage to the Absolute.

WEDNESDAY, DECEMBER 10.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Sir Robert Jones: The Problem of the Cripple Child.

UNIVERSITY COLLEGE, at 5.30.—A. Gomme: Technical and Scientific Libraries.

THURSDAY, DECEMBER 11.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—F. W. Twort: Modern Bacteriological Technique. (Succeeding Lectures on December 12, 15, 16, 17.)

FRIDAY, DECEMBER 12.

KING'S COLLEGE, at 5.30.—Prof. A. V. Hill: Scientific Method.

SATURDAY, DECEMBER 13.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Glory that was Thebes.

NATURE

SATURDAY, DECEMBER 13, 1924.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2876, VOL. 114]

Science and Labour.[1]

BOTH science and labour owe a sincere debt of gratitude to the British Science Guild for its efforts, through the Conference held at Wembley at the end of last May, in establishing contact between two movements so clearly destined to change the nature of society. If nothing more has been accomplished than to establish a precedent for a periodical scrutiny of our social and industrial relations in the scientific spirit, the British Science Guild will have erected a monument to itself.

The avowed object of the conference was, to quote Lord Askwith, "to consider the lines upon which science could be directed and applied more widely and effectively to increase human health, happiness and efficiency, to reduce human toil, and to develop human personality."

Considering the scope of such an inquiry, and it embraces within its ambit the whole field of sociology, it would be amazing if any definite or concrete conclusions emerged; but while no attempt was made to collate the ideas expressed by the large number of speakers in any concise form, certain common lines of thought are easily discernible. In particular, the belief was constantly reiterated that the industrial problem must yield to scientific solution. "The scientific method," asserted Sir Thomas Holland, "is just as necessary in industrial affairs as in matters of less immediate economic importance." "It is vital," said another, "that established systems and practices should be re-examined from a scientific standpoint"; and Sir Richard Gregory: "The new conditions of industry demand a new system of industrial management." At any rate, on the part of the scientific man uncontaminated by industrial conflict, there is a real desire to approach this question in the true spirit of inquiry.

While, however, this is undoubtedly true, there is a danger against which he must be guarded. It is natural that scientific men immersed in the study of questions bearing directly or indirectly on the problem of material efficiency should regard the industrial system as centring mainly around the question of production, and it is significant that throughout the whole of this inquiry each speaker on the scientific side, almost without exception, made his contribution to this question as if it were the whole problem. Sir Hugh Bell, taking heart from his numerous supporters in this respect, was perfectly frank about it. "The one thing towards which we should struggle is . . . to aim at larger productivity," he asserts with emphasis.

1 "Science and Labour: being the Principal Addresses at the Conference on Science and Labour held in London on 30th and 31st May 1924." Edited by Thomas Lloyd Humberstone. Pp. 120. (London: Ernest Benn, Ltd., 1924.) Paper, 6s. net; cloth, 7s. 6d. net.

It is equally natural that labour, with its memory ever fresh of bitter struggles against long hours and low wages, should stress much more acutely the complementary problem of distribution of the products of its toil, remaining largely apathetic to talk of more efficient production. Mr. Cramp puts it quite bluntly when in his address he says that labour in the past has had reason to regard every labour-saving device as a wage-saving device. The labour leader will find it difficult to wax enthusiastic about science, except as a pure matter of intellectual interest, so long as scientific workers remain indifferent to the ultimate division of the wealth in the creation of which they so ardently desire to assist, ignoring the distinction between those who create wealth and those who acquire it. With all the goodwill in the world, an infinity of round-table conferences will not destroy that barrier until men of science are prepared to examine the question of distribution in the same spirit and with the same energy as they are doing in the case of production.

It is mainly for this reason that, on a study of the addresses delivered and the discussions that ensued, it is clear that, practically with one exception to which we shall presently return, the battle was not waged by the scientific men in the field of labour or by labour in the sphere of science, but by science in the realms of applied science. For that reason the employer of labour, ignoring the problem of distribution, had his full say, and science found little to urge in criticism, while labour itself was absent from the discussion. When Sir Hugh Bell ventured the above-quoted plea for more and more intensive production, there is no evidence that a single voice, scientific or labour, was raised to question the dictum or to suggest the necessity for the scientific statement of other essential conditions.

If science is to raise production to such a pitch of efficiency that everything essential to the community can be produced in sufficient quantity by a limited group of workers, it is clear that the remainder must starve unless means are adopted for placing purchasing power in their hands; that is to say, for effecting some form of distribution. The present stage of society, which utilises the wage system as a means of effecting distribution, with its million unemployed, is obviously chaotic in this respect, and from the scientific point of view utterly indefensible. It is apparent that so long as the sale of labour power by the individual worker, and thereby the receipt of a wage, is the procedure that is to be adopted for effecting distribution, so long will labour as a whole remain apathetic—if not antipathetic—to scientific schemes of production that may decrease his opportunities for such sale.

Science must face this question squarely. It is contended by Lord Ashfield, in his intensely interesting address describing the historical and scientific development of the London omnibus service, that the introduction of scientific improvements into the system, while it may have led temporarily to the employment of fewer workers in the industry, ultimately swelled their numbers. This provision of employment, he asserts, was therefore something which redounded to the benefit of labour. Apart from the fact that the sudden cessation of employment among the men initially displaced laid the brunt of an unsound distributive system immediately upon a group scarcely fitted to withstand it, it is not clear that anything more was finally achieved in this respect than that men were merely transferred to more productive employment; and, as we have already indicated, mere productiveness is not sufficient in itself. If Lord Ashfield's contention were valid, one would anticipate that since the industrial revolution the percentage of unemployed would have decreased continuously. We doubt if this would be borne out by the facts.

Even on the productive side there are questions which, merely from lack of examination, we are prone to prejudge. We have become accustomed to the constant repetition of the phrase "speeding up," and in the mind of labour it is associated with much of the valuable work done on industrial psychology. But suppose the individual workman be urged to work at his maximum capacity, will his output be increased 20 per cent.? Now suppose the employer be urged to introduce the maximum of science and scientific method into his factory, by how much will the output ultimately be increased? We would suggest that the history of the cotton industry, where the output since the age of scientific invention has increased something like fifty-fold, is illuminating. How futile when viewed in this light does the grudging attitude of many captains of industry to science and labour become. How inefficient also are the means adopted for bringing the perfected article to the consumer is apparent when we recollect that for most proprietary articles, out of every three produced approximately two are absorbed in providing the third with what the economists would term "utility of place."

The single field upon which all groups appear to have met was that set for "The Place of Science in Government," and here a discussion arose of intense moment to all scientific workers whose interests extend beyond the mere confines of their laboratory. The gauntlet was thrown by Mr. Sidney Webb, who, in the course of his address on "Knowledge and Control," asserted that concentration on scientific work frequently gave rise to a narrowness of outlook and that this inevitably implied that the scientific expert, while he had a place, and a distinct place, would not find it as an adminis-

ative or as a governmental head even, it is presumed, hen the subject of administration was scientific. The nction of the politician, he contended, was to interpret he will of the people, and on the expert guidance fforded him by the man of science, to express this will s a detailed practical policy. On this challenge there ere, of course, not lacking protagonists with a memory f past or present lay control of their scientific work to ttack various aspects of this point of view. If only or this part of the discussion, the report of the Conerence is well worth study.

It is a strange doctrine that because a cramped utlook is sometimes associated with extreme concenration on scientific work—and we venture to suggest hat this is not confined to scientific work—there must e a definite limitation of the administrative scope ven of those who have avoided this narrowness. This ictum can have any validity at all only if it can be emonstrated that a true scientific training is inferior in eneral as an educational influence to that of any other, nd that the scientific method is of little moment in overnment and administration. Unfortunately, any ttempt to discuss this question with those who themelves have escaped a scientific training immediately eveals a fundamental confusion between what is neant by the scientific method and what is a mere umble of chemical or physical facts and propositions in Euclid. To some extent our school and university eaching, where it ignores the broad underlying rinciples of scientific knowledge and inquiry, and harps too insistently on the mere technical facts, is artly to blame for this false conception of the true educational value of science. But in any event Mr. Webb's attitude on this matter would appear to run directly counter to the spirit of the whole Conference, that the scientific method is essential to the solution of industrial problems.

If we are to re-examine old-established systems and practices from the scientific point of view, we must join issue with Mr. Webb at even an earlier point than this. He is satisfied apparently that, all things considered, we are happy in the possession of a democratic system in which the considered will of the electorate as interpreted by the politician is put into effect by him with the guidance of the expert where the politician deems it necessary. Can it be contended in all seriousness that the present conditions under which electoral decisions are registered are even an approximation to the type of democracy Mr. Webb has in mind, or from the point of view of the scientific man, even a remote approach to an efficient instrument for deciding matters of fundamental communal importance? If it is desirable that even on matters of minor scientific consequence an unfettered unbiassed judgment should be exercised, and that at moments of such decision external distractions and emotional factors should be absent, how much more important is it that on matters of national consequence, involving the welfare of millions for years, at least similar conditions should apply? Is it necessary to point out that, with a press for which liberty is licence and prejudged issues are truth, it is impossible at a general election to attain the requisite calm for the exercise of a considered judgment by a democracy ill-equipped to rise above the passionate clamour of parties? It may be necessary to tolerate this at present as the only instrument to hand, but let us not at least be blind to its inherent weaknesses, so that in establishing an administrative and governmental machine upon it, none of the more grotesque results of democracy as practised at present should be exaggerated.

We have not done justice to this record of a notable occasion. It abounds in material of fundamental importance to the scientific and labour movements, and we can only hope that the British Science Guild, taking heart again from its experience this year, will place one more stone next year upon this worthy structure.

H. LEVY.

Activity of Vesuvius, 1903-1921.

The Vesuvius Eruption of 1906: Study of a Volcanic Cycle. By Frank A. Perret. (Publication 339.) Pp. 151 + 24 plates. (Washington: Carnegie Institution, 1924.) 4 dollars.

THIS valuable monograph gives the results of the author's investigations on the state of Vesuvius from the end of 1903 to 1921, and more especially his observations on the mountain during the height of the eruption of 1906, which culminated in the stupendous outbreak on the night of April 7-8. The volume is divided into five sections. The first deals with the events of 1904–5, the second with the eruption period in April 1906, the third with the post-eruptive period of repose, and the fourth with the seven following years of present activity. The fifth contains descriptions of apparatus invented or modified by the author for better determinations of temperature and the perception of subterranean sounds, etc., and also of diagrams for recording the phenomena concisely. A postscript by Mr. H. S. Washington deals with the analyses of lavas which have flown from the crater at different periods and gives some useful notes. There are 24 full-page plates and 98 text-figures, which are mainly reproductions of excellent photographs made by the author.

The volcano's activity began at the end of 1903, and during the next two years good opportunities of

investigating the phenomena were afforded. The cone was steadily rising in height until in May 1905 its top was nearly 4400 feet above sea-level. The vent was small, and the lava reached nearly, if not quite, to the top, whence it was ejected several hundreds of feet from time to time. Such portions as fell on the outside were still hot and plastic, and helped to consolidate the cone. On May 27, the author saw a white cloud shoot from the side of the cone at a short distance below the top, and this was quickly followed by a flow of lava. Soon there were three streams flowing from fractures at points near one another, but at different levels below the top. These relieved the extreme pressure on the cone, and the great outbreak was postponed.

As depicted by the author, the mountain differed widely from its state in 1902, when the crater was wide and deep with a small vent near its middle, from which stones were occasionally thrown up a few feet. During the summer of 1905 the author had an experience of the way in which the cone was being corroded by the hot fumes and lava within. Standing with some students on the side of the cone, they noticed that the ground began to get hot, and it soon became unbearable. Soon after they had moved off, a patch about 2 yards across became red-hot, fused, and gave rise to a small lava flow.

The main eruptive period may be said to have begun in February 1906, when there was an abundant flow of lava with loud explosions, and clouds of ash were thrown out. This state continued with some abatement until the equinox, when jets of lava were thrown out, some horizontally, so that the cone was filled to the brim. The final stage began at midnight, April 4-5, when lava poured out of a new opening on the south side at a height of 2600 feet above sea-level. On April 6 the lowest vent opened about 5 furlongs east of the last, and about 600 feet lower; from this and an adjoining vent poured out the mass of lava which reached and blocked the railway at Bosco Tre Case. The eruption culminated about 3.30 A.M. on April 8, with a great outburst of hot ash, lava, and debris, some of which caused the serious catastrophes at Ottajano and S. Giuseppe, where they were deposited to a depth of nearly 3 feet. The next extraordinary event was the great uprush of gas about 4 A.M. This is represented by a drawing and not a photograph; it is made to ascend to a height of about 8 miles, and marked, according to the author, the *intermediate gas phase*, the gas coming from great depths and being comparatively free from ash. It was followed on April 8 and subsequent days by the dark-ash phase, the columns and billows of which probably attained a height of 3 miles above the crater. The mountain and country round were covered with a great depth of ash, which on the steep slopes gave rise to dangerous hot avalanches, and at a later period to mud avalanches, from which the towns have to be protected by strong walls. The loss of material caused two subsidences near the top of the mountain, and reduced its heights by 350 feet on the N.W. side and 700 feet on the opposite side, the crater becoming a wide-throated funnel some 770 yards across at the top and sloping down at an angle of nearly 45°. Estimates of the quantities thrown and poured out differ widely, but the flow of lava on the southern flank covers about 3,000,000 square metres, and its volume is about 10,500,000 cubic metres.

The author discusses at some length the possibility of a luni-solar influence on eruptions, but leaves the question open. Now the difference of attraction on so small a volume must be inappreciable in its effect on so viscous a substance as liquid lava, and independently of this, the active stages in February and April preceded the full moon by seven and five days respectively. Palmieri, in his account of the 1872 eruption, seems to favour the view, for he says: "in the month of March, with the full moon, the cone opened"; and later, "on the 23rd April (another full moon) . . . splendid lavas descended." Earlier, however, he states that on November 3 and 4 "copious and splendid lava streams coursed down," the moon being full on October 28 and November 27.

The seismic disturbances and subterranean noises were very considerable and were powerfully felt at Pompeii, and probably at greater distances. With the friction of the matter ejected great electrical energy was developed, and manifested itself in short lightning flashes over a considerable portion of the sky.

The narrative portion of the book is extremely interesting, and the discussion of the phenomena is full of suggestion and shows good discrimination.

W. J. L.

Lime and Magnesia.

Lime and Magnesia: the Chemistry, Manufacture, and Uses of the Oxides, Hydroxides, and Carbonates of Calcium and Magnesium. By N. V. S. Knibbs. Pp. 306. (London: Ernest Benn, Ltd., 1924.) 30*s.* net.

THE work under notice is the first book or collection of classified information on the manufacture and properties of lime and magnesia which makes any pretence to be a comprehensive survey of the situation. As such, the author is to be complimented on the result of what must have been to him a long and painstaking piece of work. The volume is divided into three parts: Part I., occurrence and classification of limestone and magnesite, and the chemical and physical properties of

ne and magnesia; Part II., quarrying and manufacture lime and magnesia products, and Part III., their use commerce and industry. Of the three, the first may be said to be satisfactory, the second to be less so, and he third to be a rough attempt to outline the very aried uses to which lime and magnesia products are ut. It is questionable whether it would not have been dvisable to publish the three parts in separate volumes, nd make those on manufacture and usage very much ore exhaustive. This would, it is true, be even more borious, but the ultimate value of the work would have en greatly enhanced. Moreover, had the author llowed this course, he need have had no fear of being restalled in the field.

In dealing with each section separately, the following oints seem to be of interest. The classification of arious limestones is good, and an admirable feature of he book is the bibliography and references at the end each chapter. There is a fairly ample discussion on he work of Johnston on the thermal dissociation of mestone. It seems to be the only really first-class esearch which has been done in this field. The method etailed for measurement of the apparent density of me seems somewhat crude, and it is unfortunate that o better method has been described for measuring this roperty, from which most of the other physical properties of the sample can be determined. The remainder fairly exhaustive, but it would be interesting had the uthor expressed his own opinion on the relative merits f some of the diverse facts and theories which he has ollected. On the whole, this section is very capable, hough it seems a matter of conjecture whether the nglish lime burner, practical man as he loves to style imself, will take much account of it.

Of the remainder of the book there is not so much o be said. Part II. contains a long harangue on the ncient kilns which are so much in favour in Great ritain. There seems little to recommend them, save hat they have been in use for generations. Rotary ilns are scarcely mentioned, though they are a standard art of the equipment of most American lime works. ittle as one likes to admit it, the English lime-burning ndustry is a very poor second to American practice and utput, even though we are far ahead of them in respect f our quarry resources. Hydration is far too scantily reated, though, of course, the English output is quite nsignificant and the product high in price. Quarrying s very lightly passed over, and only a very general urvey of accepted methods is undertaken.

The section on the uses of lime and magnesia products s as good as it can be in the space devoted to the ubject, which is very small compared with its importance.

As a whole, the book appears to be a fairly comprehensive survey of the lime and limestone industry, but not so much so in the case of magnesia. As an incentive to research it would seem invaluable. The author has, so to speak, broken the ice, and accomplished his primary object successfully. It would have been more satisfactory, however, had he been far more critical in his handling of the subject, the lime industry being somewhat in need of it. F. A. FREETH.

Antarctic Meteorology.

British Antarctic Expedition, 1910–1913. Meteorology. Vol. 3: Tables. By Dr. G. C. Simpson. (Published for the Committee of the Captain Scott Antarctic Fund.) Pp. xi+835. (London: Harrison and Sons, Ltd., 1923.) 60*s*.

THE physical researches of the *Terra Nova* expedition are now complete in 13 volumes, including one of miscellaneous data still in the press. Dr. Simpson published the first two volumes of the meteorology of Scott's last expedition in 1919, the first containing the discussion of the data and setting forth his conclusions, the second reproducing the weather maps and traces of recording instruments. Volume 3 now supplies the data on which the earlier volumes were based, including hourly readings of all the instruments at the main base, Cape Evans, and the meteorological logs kept at the various subsidiary bases and on journeys. It is a massive monument of the rare devotion with which Dr. Simpson and his many helpers worked in circumstances of the greatest difficulty, and the survivors of them are to be congratulated on its completion. Dr. Simpson must be thanked also for not delaying by five years the publication of his epoch-making general conclusions, to wait for the end of the labour of seeing this huge volume through the press.

In the preface it is pointed out how greatly the value of the meteorological work was enhanced by the concurrence of the Norwegian expedition in the journeys to the South Pole, a subsidiary part of Scott's expedition although the main aim of Amundsen's. Through the unexpected advent of the *Fram*, Scott's eastern party was diverted northward to Cape Adare while the meteorological work at Framheim gave a third series of highly accurate synchronous observations for very nearly a whole year. As Cape Adare is 400 miles north and Framheim 400 miles east of Cape Evans, the three stations enabled synoptic maps to be constructed of the whole Ross Sea area. It is to be regretted that the meteorological data of the Australian Antarctic expedition, which was simultaneous with the second year of Scott's expedition, could not have been dealt with also in these volumes.

In addition to the records at the fixed stations (those at Framheim being given in the British units) the volume includes the meteorological logs of all the sledge journeys and of the voyages of the *Terra Nova* from and to New Zealand. The utmost care was taken in all these observations to define the time-standard used and the true direction in the case of wind and of cloud movements; both these items present difficulties peculiar to very high latitudes, and carelessness in regard to them has deprived some past records (made otherwise with the greatest care) of all their value.

This volume has its sole use as a work of reference, and it ought to prove invaluable when the time comes for a critical discussion of Antarctic meteorology in the light of all records, including those of expeditions the detailed work of which is still unpublished.

Vol. 1 of the meteorology, which was printed in India, is provided with a running title greatly facilitating reference and permitting of the workmanlike numbering of the pages in the outer upper corner; Vol. 3, printed in London, conforms in this respect not to Vol. 1 of the meteorology set, but to the volumes dealing with the other departments of science, which unfortunately have no page-headings. This is neutralised in the case of tables printed across the breadth of the page and only causes delay in referring to the tables which are printed across the length of the page. A more serious defect is that the volume under notice (like most of the others) is numbered awkwardly in the middle of the page at the bottom, so that it is necessary to make a complete opening in order to see the number, instead of merely flicking the top outer corner. H. R. M.

Our Bookshelf.

A Survey of the Fauna of Iraq: Mammals, Birds, Reptiles, etc. Made by Members of the Mesopotamia Expeditionary Force "D," 1915–1919. Pp. xx+404+20 plates. (Bombay: Bombay Natural History Society; Basra and Baghdad: *The Times* Printing and Publishing Co., Ltd.; London: Dulau and Co., Ltd., n.d.) 10*s*. net.

THE study of the survey of the fauna of Iraq is a convincing proof that the interest in systematic zoology is still well maintained in Great Britain. It is really very remarkable that notwithstanding the hardships and discomforts of the campaign in Mesopotamia, no less than eighty-four of the members of the British Expeditionary Force "D" were keen enough to collect and observe the animals of the country through which they passed or in which they fought.

The papers which constitute this volume were first published in the Journal of the Natural History Society of Bombay, and are now reprinted and published with the authority of the Iraq Government. They deal with the mammalia, birds, reptiles, insects, myriapoda, and crustacea that were collected during the year 1915–1919. The only large groups of terrestrial o freshwater animals that are not included in the volum are the mollusca, arachnida, and fishes. It would b interesting to know if material belonging to these group were also collected and will be described in later papers

With a book of such great value and varied interes it is impossible, in a short notice, to convey a jus appreciation of its manifold merits. To some natural ists the papers on the birds by Buxton and Ticehurs will appeal most strongly. Dr. Buxton's notes on th avi-fauna of Northern and Western Persia are par ticularly interesting and well written, giving a ver vivid impression of the birds that may be seen in journey through the country by any traveller wh possesses the keen sight and knowledge of a trained an gifted ornithologist. Dr. Ticehurst's contribution o the birds of Mesopotamia, with its more detaile account of the species, including most interesting note on their habits, nests, and eggs, is rendered mor fascinating by some remarkably good photographs o the nesting places of many of the birds.

To others the more attractive papers will be those o Col. Piele on the butterflies. Here, again, the autho is not content to give a simple list of species in th collection, but adds many valuable notes on variatio and habits. The naturalist who is not a professe entomologist will read with much interest, for example the three pages of notes on the well-known swallow-ta *Papilio machaon*.

In selecting these two series of papers for specia mention, we have no wish to underrate the value an importance of the others in this volume. Every pape has been written by a well-known authority in hi group, and, so far as we can judge, it has been treate with the greatest possible accuracy and care.

We can only congratulate the many authors an collectors on the production of such a remarkable an valuable work.

Leaves from the Golden Bough. Culled by Lady Frazer Pp. xii+249+16 plates. (London: Macmillan an Co., Ltd., 1924.) 10*s*. 6*d*. net.

IT was a happy idea of Lady Frazer's to transform by a few magical touches the learned treatise o anthropology into a fascinating book of stories fo children. It is remarkable how readily young folk will respond to good literature, to true talent and t real wisdom. Any one who wishes can convince himsel by experiment of this fact by observing how children of four years onwards will listen with delight t properly chosen passages from Homer, Shakespeare and Cervantes. Frazer's "Golden Bough" contains the most universal and catholic collection of stories customs, and practices, and these in illustration o some of the most dramatic and mysterious aspects o human nature; and it is told with a unique charm and power by the illustrious author. From thi masterpiece of literature and science, Lady Fraze has judiciously selected a number of appropriat incidents which will impress once for all on the youn mind the most important facts of anthropology. Th child will be keenly interested to hear what the mistleto bough really means in the Christmas festivities an what it meant to our ancestors. He will follow eagerly

he strange adventures of ancient heroes of Greece, of he semi-animal gods of Egypt, the sagas of Teutons nd the folk-tales from five continents and numberless slands.

The wide range, the extreme variety of local colour, he flavour of the distant, of the primeval and of the xotic, so wonderfully preserved by Sir James Frazer, vill be a delight to every young reader who, as we now, is so susceptible to the lure of the remote and antastic. What makes this book unique, however, s not its harvest of folk-lore, but the accounts of elief and custom which form the bulk of the selected assages. The child finds himself in real intimacy with Red Indians and their hunting expeditions and lodge estivals, with South Sea Islanders in their fishing and loral dances, with the hairy Ainu of Japan worshipping he bear. Moving through the wonderful landscapes of the world, tasting of genuine savage life, sharing he beliefs of all ages and all races, the child will eceive at the same time an excellent foundation for is future humanism. The pleasing illustrations by Mr. H. M. Brock add another touch of life to these ntrancing pages.

The Mortality of Annuitants, 1900–1920: Investigation and Tables. By W. Palin Elderton and H. J. P. Oakley. (Published on behalf of the Institute of Actuaries and the Faculty of Actuaries in Scotland.) Pp. iv+207. (London: C. and E. Layton, 1924.) 42*s.* net.

MESSRS. Elderton and Oakley have given an account of their investigation into the mortality of annuitants as ascertained from data supplied by the leading Life Offices in Great Britain. The investigation covers the period 1900–1920, whereas the tables previously in use related to the years 1863–1893. A striking decrease is shown in the rates of mortality of both men and women, and this fall in the rate of mortality has led the authors to propose a method of forecasting the mortality likely to prevail in the future. For this purpose they assume that the rate of mortality applicable to a given age-group can be expressed in the form $A+Bc^x$, where x is the calendar year in which the annuity is purchased.

The constant A for any age-group thus represents the figure to which the rate of mortality will ultimately fall. This is taken arbitrarily at 63 per cent. of the 1900–1920 rate, and the required value of the forecasted rate of mortality is then found by logarithmic exterpolation from the values given by the 1863–1893, and the 1900–1920 data, the assumed year of purchase being calculated for each age-group from the average duration of contracts in force. For example, in the age-group 80-84, where the average duration is 16 years, the forecasted rate of mortality for those ages, in respect of an annuity purchased in the year 1925, is that applicable to the year 1941, and this average rate is apparently taken whether the annuity be purchased at the age of 40 or at 80. In the result it would seem that the method must tend to overstate somewhat the projected annuity values at the older ages.

The book concludes with the usual adjusted life tables and monetary tables for single and joint lives. It will be of the greatest value to all who require an up-to-date mortality experience of a sheltered class.

A Treatise on Light. By Dr. R. A. Houstoun. New edition. Pp. xi+486+3 plates. (London: Longmans, Green and Co., 1924.) 12*s.* 6*d.* net.

DR. HOUSTOUN'S text-book, which was first published in 1915, has achieved a wide and well-deserved popularity, and the present edition is supplemented by a short additional chapter on "Recent Advances." Frankly, it is a disappointing chapter. First, the interferometric determination of the angular diameters of stars is briefly treated from an elementary point of view, then half a page is rather unnecessarily expended on descriptions of half-watt and neon lamps. There follows an account of the verification of Einstein's predicted gravitational deflexion of light, but no mention is made of the application of the theory in connexion with the fine structure of spectral lines. The quantum theory is next discussed. This is admittedly a difficult matter to expound in the space of a page, but even so Dr. Houstoun might have given us a more inspiring survey of this fascinating subject. Even the most impenitent classicist should be capable of appreciating the remarkable achievements of the quantum theory, and one cannot help feeling that the bald and unilluminating account here presented is unworthy of the rest of the book. Further, in the final section, which is entitled "Moseley's Work on X-ray Spectra," a statement occurs which can scarcely pass unchallenged. It is that "the examination of spectra in the visible region and near ultra-violet, while affording many interesting results, has not been fruitful as regards the structure of the atom or the mechanism of the production of spectra itself." After this, it is not so surprising to find no mention of Bohr anywhere.

It is greatly to be hoped that in a future edition a more adequate treatment of these matters will be attempted. At the same time, Dr. Houstoun should take the opportunity of rewriting the account of spectral series on pp. 271-275, which is now completely out-of-date.

Cancer: its Causation, Prevention and Cure. By Dr. John Harger. Pp. xv+139. (Liverpool: C. Tinling and Co., Ltd., 1924.) 5*s.*

UNTIL the cause of cancer is discovered, it will remain common ground for ill-informed persons to express their views. The most recent amateur recruit to the cancer problem is Dr. John Harger—apparently a chemist—who considers that as such he has had a "precious legacy," handed to him by Pasteur, namely, "the *right* to interfere in matters of logic, especially when applied to subjects treating of disease." In spite of the statement (p. 132) that "This legacy we must guard and use with discretion, lest it be besmirched by our blundering," his book might be described as a compendium of erroneous and useless elementary anatomical, physiological, and pathological data. In an amusing glossary we find "Atrium (the open court).—The auricular parts of the heart." "Cervix" is said to be the "neck of an organ, etc." "Fibrin" is defined as the "protein in the fibrous parts of the body and in the membranes, cell walls, etc." The suprarenal capsule is a "small attachment to and above each kidney." We are also told that;

in cancer patients, "the red blood corpuscles possess nuclei, which is not the case in normal health."

It is difficult to make out the author's real viewpoint on cancer, but apparently it has something to do with diet. He extols the virtues of Dr. R. Bell, Mr. Forbes Ross, and Dr. John Shaw; and accepts in part their very diverse theories. Incidentally, he is critical of Mr. Ellis Barker and surgeons.

Ore Dressing: Principles and Practice. By Prof. Theodore Simons. Pp. xviii + 292. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 17*s.* 6*d.* net.

TEXT-BOOKS of ore dressing are frequently little more than extracts from makers' catalogues. The volume by Prof. Simons is of a different character. It gives the usual descriptions of plant, but enters more fully into the principles of the processes of separation and deals quantitatively with the theoretical and practical limits of concentration, and with the theory of grinding. It is readable and should be found exceedingly useful by metallurgists in general. The subject of flotation is rather briefly treated, and the theory, of such remarkable scientific interest, is only alluded to, the reason being given that several important works devoted entirely to flotation have been published recently. Magnetic separation might with advantage have been treated more fully. It is extremely important, and the apparatus figured and described is only one of many efficient types. It is unfortunate that this subject should not have been treated with the same fulness as the mechanical processes, as the applications of magnetic separation are continually increasing. Should a further edition of the book be required, several sections might be expanded with advantage without altering the general character of the work or injuring its readable quality.

C. H. D.

The Structure of Matter. By Dr. J. A. Cranston. (Manuals of Pure and Applied Chemistry.) Pp. xvi + 196. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1924.) 12*s.* 6*d.* net.

MOST of the books dealing with the structure of matter have been written rather for the physicist than for the chemist, and there was room for a simple yet sufficiently detailed account of the subject treated from the chemical point of view. Dr. Cranston would seem to have filled this gap very successfully. He gives a preliminary account of the determination of the mass and charge of the electron, of radioactivity, atomic numbers, isotopes, and crystal structure, in all cases giving adequate descriptions of the experimental methods, and then proceeds to discuss the various atom models, and the valency theory of Langmuir. The space devoted to the Bohr atom may seem inadequate, but it must be confessed that its chemical applications are still vague and that Langmuir's ideas, although probably less physically sound, seem to afford greater assistance in this field. This part of the subject is well explained. The book is attractively illustrated, and references for further reading are given. Both teachers and students of chemistry will welcome Dr. Cranston's quietly written book as the best for their purpose which has yet appeared.

Practical Calculus for Home Study. By Prof. C. I. Palmer. Pp. xx + 443. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 15*s.* net.

THIS book is professedly written for the practical man who, having already a considerable knowledge of subjects that lend themselves to mathematical formulation and discussion, has yet a very indifferent mathematical equipment. For success in its purpose such a book must satisfy two requirements. It must, in the first place, continuously correlate each complete step in the analysis with concrete problems of practical significance, so that the reader may feel at no stage that he has lost touch with his solid ground. In the second place, the development of the subject must fit into a general scheme in order that the existence of wider fields of inquiry may not be obscured. The present volume, with effectively the same range as most elementary text-books on calculus, fulfils the first of these requirements with a considerable measure of success, practical examples being taken from almost all branches of physics and engineering, besides those of a purely mathematical nature. To satisfy the second requirement is much more difficult in the circumstances, and the author has at any rate made it apparent that he is alive to its importance.

(1) *Technique of Tissue Culture "in Vitro."* By T. S. P. Strangeways. Pp. xii + 80. (Cambridge: W. Heffer and Sons, Ltd., 1924.) 7*s.* 6*d.* net.

(2) *Tissue Culture in Relation to Growth and Differentiation.* By T. S. P. Strangeways. Pp. x + 50 + 4 plates. (Cambridge: W. Heffer and Sons, Ltd., 1924.) 5*s.* net.

(1) FOR some time the author has been known as a most successful cultivator of living tissues *in vitro*. His small book describes in the minutest details his technique, and is a notable contribution to the subject; it is invaluable to those who wish to follow this promising line of work.

(2) It is not quite easy to understand why this booklet was separated as a fragment from the author's other work described above, and why its dimensions should be different. It deals with observations of tissue cultures and their possible significance in relation to growth and differentiation. The author's meaning is not always apparent, and in some places the writing is involved, but the book must be ranked as an important if short contribution to a fundamental subject of biology.

Problems of Belief. By Dr. F. C. S. Schiller. (Library of Philosophy and Religion.) Pp. 194. (London: Hodder and Stoughton, Ltd., n.d.) 3*s.* 6*d.* net.

DR. SCHILLER'S little book is a serious contribution to a large philosophical problem. The author's irrepressible humour enlivens the subject and prevents it being for a moment dull. Some years ago, Dr. Schiller sent out a *questionnaire* with the view of discovering how far the desire for a future life is general, and how far, in those who acknowledge it, it is modified by the conditions they attach to it. Many of the answers were surprising and not a few entertaining. An appendix inserted in the middle of the book gives an account of this interesting experiment.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

The Influence of the Degree of Instability on the Phenomena of Round Liquid Columns.[1]

THE instability of round liquid jets was noticed and described by Savart,[2] Magnus,[3] Plateau,[4] and others. The criterion of instability was given by Plateau as

$$\frac{\lambda}{d} > \pi, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where λ is the "wave-length," measured along a portion of the jet where the diameter is d. Or, in words, the jet is unstable when the wave-length is greater than the circumference.

This criterion depends only upon the tension of the surface and applies to any round column of fluid bounded by such a surface. Thus Boys[5] demonstrated this instability by a purely static experiment, in which a soap film was stretched between the circumferences of two equal and coaxial rings, and these were drawn apart along their common axis. The film collapsed when the distance between the rings was equal to the circumference of either.

The late Lord Rayleigh recognised that the question whether or not an actual jet breaks up in the allotted time, depends also on the *time rate* of its collapse, and thus on physical and geometrical properties of the jet other than its surface tension. This fact seems, however, to have been overlooked by many others. It seems worth while, therefore, to emphasise its significance by a few illustrations of phenomena that depend on this consideration for their explanation. The purpose of the present communication is to furnish these illustrations and to put the factors on which this rate depends, deduced by Rayleigh, into more convenient form for study.

In Rayleigh's treatment[6] external forces were neglected, as was any uniform forward motion common to all parts of the jet. The jet was thus treated as an infinitely long cylinder of liquid initially in equilibrium under the action of the tension of its envelope. The disturbances by which this equilibrium was upset were assumed to act independently of one another. The change in potential energy, caused by a given disturbance, was computed from geometrical considerations, while the kinetic energy, due to the motion of the liquid caused by the disturbance, was evaluated on the assumption that a velocity potential existed. Application of Lagrange's generalised equations of motion then gave the differential equation stating the time rate of variation of α, the "amplitude" of the disturbance. The solution of the equation was found to be

$$\alpha = \alpha_0 e^{qt}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where e is the Naperian base,

and

$$q^2 = \frac{8T}{\rho} \frac{[F(z)]^2}{d^3}, \quad . \quad . \quad . \quad . \quad . \quad (3)$$

In (3) T, ρ, d denote surface tension, density, and diameter, respectively;

and

$$[F(z)]^2 \equiv \frac{z}{J_0(iz)} \cdot \frac{\partial}{\partial z} J_0(iz) \cdot (1 - z^2) \quad . \quad . \quad (4)$$

Here

$$z \equiv \pi d/\lambda \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and

$$J_0(iz) = 1 + \left(\frac{z}{2}\right)^2 + \frac{1}{(2!)^2}\left(\frac{z}{2}\right)^4 + \frac{1}{(3!)^2}\left(\frac{z}{2}\right)^6 + \ldots \text{ etc.} \quad (6)$$

Aside from the factor $(1 - z^2)$, the rest of the second member of (4) is real and positive; hence q is real if $\lambda > \pi d$ and imaginary if $\lambda < \pi d$. Imaginary values of q correspond to stable oscillations of cross section, but when $\lambda > \pi d$ so that q is real, the amplitude α increases continually,[7] until, when $\alpha = d/2$ the jet breaks up into drops, the rapidity of this collapse increasing with q.

FIG. 1.—The collapse of a round falling liquid jet.

Now it is seen from (3) that the value of q, for a given liquid, is determined by two factors: (*a*) it increases as d decreases; (*b*) it increases as $F(z)$ increases. A necessary accompaniment to the study of the phenomena of any jet is, therefore, a study of these two factors.

As to (*a*), the increase in q, being 50 per cent. greater than the decrease in d which causes it, can be readily computed once the change in d is known. Unfortunately this latter is often difficult to determine in the case of a jet; but it is often possible to get an approximate idea of this change, and even this should be considered in any attempted explanation of given jet phenomena.

Fig. 1 is a typical spark photograph of a round jet of water, falling vertically. The orifice chamber was influenced by an electrically driven tuning-fork, the energy of which was propagated in a direction parallel to the axis of the jet. The fork frequency (n), head causing *efflux* (h), and *jet* diameter (d) were mutually adjusted to satisfy the inequality

$$\frac{\sqrt{2gh}}{n} > \pi d \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Therefore, since the vibrations served merely to regularise the disintegration process, and since this photograph is typical of the form of the jet at any instant, it may be taken as picturing, *at intervals of* λ, the progress of a disintegrating disturbance impressed at the root of the jet.

We note the formation of an indentation in the surface, due to the vibration. This soon grows into a ligament separating the swellings of the main jet. This ligament, having a λ/d ratio greater than π, is unstable, and collapses in the manner indicated above. But its degree of instability is very high, on account of its small diameter. Further, since the ligament is getting progressively finer, its degree of instability is at the same time increasing. q is, therefore, an *implicit increasing* function of t. The ligament thus collapses in a shorter time than would be required for α to equal the jet radius if q were determined only by the initial dimensions of the jet, and a small drop is formed between each pair of larger drops.

Now Rayleigh, in discussing[8] the cause of the reflections of the small drops between the large drops, which is made evident by stroboscopic examination,

[1] Published by permission of the Director of the Bureau of Standards of the U.S. Department of Commerce.
[2] Savart, *Ann. de Chim.*, 53, 337, 1833.
[3] Magnus, *Phil. Mag.*, 18, 161, 1859.
[4] Plateau, "Statique experimentale et theorique des liquides soumis aux seules forces moleculaires," Paris 1873. (Access to Plateau's original memoir has not been obtained. References and quotations are taken from Lord Rayleigh's papers.)
[5] Boys, "Soap Bubbles," p. 79, 1902.
[6] Rayleigh, Proc. Lon. Math. Soc., 10, 4, 1879; Proc. Roy. Soc., 29, 71, 1879.
[7] q can only be positive if real, since such displacements cause a decrease of surface.
[8] Rayleigh, Enc. Brit., 11th Ed., 5, 271, Art. on "Capillary Action."

and by the fact that, in a horizontal jet, the small drops are thrown out of the vertical plane containing the main jet, says that this is caused by the ligament being in a more advanced stage of its development at its front end than at its rear, thus causing an initial collision between each small drop and the large drop following. Considering the facts just mentioned, this explanation seems quite plausible.

Another related phenomenon is that recorded by Ollivier.[9] He observed that, when a drop of water fell upon a smoked surface, a fine ligament was formed at rebound, causing a small drop to be projected in a direction normal to the surface. This phenomenon was ascribed by Ollivier to the fact that the length of this ligament was greater than its circumference, and it was therefore unstable. It is not evident, however, until we consider Rayleigh's work on the variation of the rate of collapse with the diameter of the liquid column, why this ligament collapsed before the liquid at its end could be drawn back into the main drop.

We must now consider the variation of q with λ/d. From (4) Rayleigh computed enough values of $F(z)$ to show the existence of a maximum, of value 0·343, at $\lambda/d = 4{\cdot}5$ (approximately). These computations have been slightly extended by the writer, and the results are shown in convenient graphical form in Fig. 2, where $F(z)$ is plotted as a function of λ/d. It should be remembered that q, which measures the degree of instability, is directly proportional to $F(z)$ for a given liquid and jet diameter.

$F(z)$ is zero for $\lambda/d \leqq \pi$. After this instability point is passed, the value of $F(z)$ increases very abruptly. This accounts for the possibility of quantitatively recognising the instability point, as in an experiment described by the writer.[10] In this connexion it should be noted that since the experimental recognition of the instability point depends on the particular form of the function $F(z)$, the practical application of Plateau's criterion is due to Rayleigh's work.

A somewhat similar experiment has been described by Lord Rayleigh.[11] He observed the following: When the orifice from which a rising jet issued was influenced by a tuning-fork of proper frequency, the jet broke on its upward path. As the vibrations of the fork died down, and the initial amplitude a_0 consequently decreased, the point at which the jet broke rose, but could not be made to pass a certain point, which Rayleigh assumed to be the instability point. Unfortunately, he records no quantitative data, so that one cannot say *from these observations* whether the (length/diameter) ratio for this point was π or some slightly greater number.

The maximum of the curve is not at all sharp. Now in some of Savart's experiments the fall of the drops formed from a jet influenced the orifice chamber, and thus determined the further rupture of the jet. Under such conditions, after the lapse of a short time, the jet collapses in a regular manner, quite similar to Fig. 1. But such a jet should pick out a value of λ/d corresponding to the maximum of Fig. 2. Now Plateau, reasoning from Savart's results, found 4·38 as the λ/d ratio for this point. Consulting Fig. 2, it is seen that the ordinate value at this point is insignificantly different from that at $\lambda/d = 4{\cdot}5$. Hence it is evident that this is a contradiction neither of the accuracy of Savart's experimental work nor of Rayleigh's theoretical work.

For values of λ/d greater than that corresponding to the maximum of $F(z)$ the curve slopes down very gently. Now it is an experimental fact that gravity has but slight effect on the phenomena in a falling jet, when λ/d is initially greater than 4·5. In such a jet, gravity causes an increase in the λ/d ratio of a ligament and a corresponding decrease in d. These have opposing effects on q. The increase in q due to decrease in d slightly exceeds the decrease in q due to increase in λ/d ratio, and the jet breaks sooner than it would according to Rayleigh's treatment, which neglects gravity.

The above quotations could be multiplied almost indefinitely, as will be evident to those familiar with the literature on the subject. It is thought that they furnish the illustrations desired.

It should be noted that we have here one example of a useful principle, which, while quite obvious, does not seem always to receive the attention it merits. It is this:

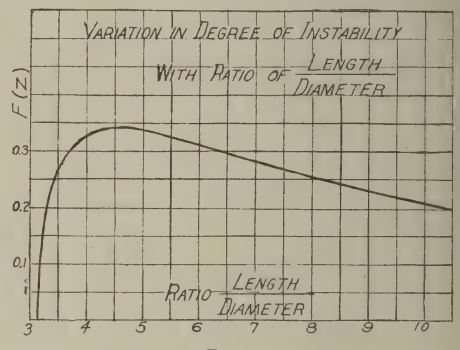

FIG. 2.

Static criteria of stability, such as Plateau's criterion mentioned above, are sufficient only in purely static phenomena, where ample time is available for the instability to predominate. In dynamic cases, at least three things must be considered: (1) the static criterion of stability; (2) the degree of instability, as determined by (*a*) the disturbances by which equilibrium is upset; (*b*) the changes through which the system under investigation will pass while the instability is acting; (3) other forces that may act simultaneously. All of which is summarised in the question: Has the instability a chance to produce its effect before something else happens?

R. A. CASTLEMAN, jun.

Bureau of Standards,
Washington,
October 28.

Electronic States of the CN Molecule.

COMPARATIVELY little attention has been paid as yet to the electronic changes involved in the emission of band spectra. In line spectra the study of resonance potentials, of absorption spectra, and of thermal excitation, have all been fruitful in the determination of electron levels. Low-temperature absorption spectra obviously involve as their less excited electronic state the normal state of the absorbing atom, or molecule. Lines, or bands, thermally excited at moderate temperatures, necessarily involve transitions from moderately excited states, very often *to the normal* state of the emitter. Familiar examples of band spectra so excited are the flame spectra of the alkaline earth and copper halides, and of boric oxide; probably many, perhaps all, these involve as an end state the normal state of the emitting molecule; the fact that these bands have not been observed in absorption may be ascribed to the impossibility of

[9] Ollivier, *Ann. de Chim. et de Phys.*, 10, 313, 1907.
[10] Castleman, *Phys. Rev.*, 21, 709, 1923.
[11] Rayleigh, Proc. Roy. Soc., 34, 130, 1882.

otaining the emitting molecules in sufficient con-
ntration in the vapour state at ordinary tem-
.ature.

An examination of the CN bands with these points
i mind gives interesting results. The long dispute[1]
s to whether carbon in addition to nitrogen is
quired for the emission of these bands seems now to
ve been decided in the affirmative.[2, 4] Without
ttempting to review the evidence, the following
portant points may be noted: (1) The supposed
lation between the constants of the red CN bands
d of the first positive nitrogen bands has recently
en disproved[2] by Birge; (2) the (red and violet)
N bands appear in active nitrogen when, and only
hen, carbon compounds are admitted[3]; (3) accord-
g to Freundlich and Hochheim,[4] when nitrogen is
ated to 2100°-2200° C. in a graphite tube, the violet
N bands are emitted in great intensity (according to
. S. King[5] they also appear in absorption at slightly
gher temperatures—about 2500° C.), but are com-
etely absent when nitrogen is heated to the same
mperature in a tungsten furnace; in this work the
d CN bands were not looked for. Evidently in the
esence of nitrogen and carbon above 2000° C., some
mpound is present which can be excited thermally
the emission of the bands. Since the band struc-
re is that of a diatomic emitter, this compound
ust be CN.[6]

The red and violet CN bands, as was shown by
eurlinger, have a common final electronic state.
he latter, it can now be stated, is in all probability
ie normal state of the CN molecule. The thermal
xcitation of the violet CN bands at the moderate
emperature of 2100° C., in spite of the undoubtedly
ery small concentration (see below) of CN molecules,
satisfactory evidence of this. The red and violet
ands, respectively, correspond then to electronic
esonance potentials of 1·78 and 3·18 volts. The
udden appearance of the bands in emission and
bsorption above 2000°, however, requires explana-
ion. One would expect CN to be formed by the
issociation of $(CN)_2$ at high temperatures. This does
ot occur appreciably, however, at or below about
00° C.[7] The matter cannot be investigated experi-
nentally above this temperature, since $(CN)_2$ begins
o decompose into carbon and nitrogen.[7]

The concentration of $(CN)_2$ *in equilibrium* with
arbon and nitrogen must, in fact, from thermo-
lynamic calculations, be excessively small at all low
nd moderate, and perhaps even at the highest,
emperatures.[8] The equilibrium concentration of CN
t low temperatures must be very much smaller still,[9]
ut may be expected to increase with temperature,
robably more rapidly than that of $(CN)_2$. Apparently
bove 2100° it becomes sufficient for appreciable
bsorption and emission of the violet CN bands.
resumably it continues to increase with the tempera-
ure, perhaps until CN becomes a relatively abundant
olecular species. The great intensity of the CN
ands in the carbon arc (temperature about 4000° C.)
is well known.[10] The bands also appear in absorption in the sun and some of the stars.[10] The low resonance potentials of CN indicate, however, a low ionisation potential, so that it is likely that CN is largely ionised at the higher stellar temperatures.[11]

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[1] This is summarised in Kayser's "Handbuch der Spektroscopie," Vols. 5, 7.
[2] R. T. Birge, paper before Am. Phys. Soc.: abstr., *Phys. Rev.*, 23, 294 1924).
[3] Cf. Lord Rayleigh and Prof. A. Fowler, Proc. Roy. Soc., 86A, 113 (1912); Lord Rayleigh, *ibid.*, 102A, 453 (1923).
[4] E. Freundlich and E. Hochheim, *Zeit. f. Phys.*, 26, 102 (1924).
[5] A. S. King, *Astrophys. Jour.*, 53, 161 (1921); R. T. Birge, *Astrophys. Jour.*, 55, 273 (1922).
[6] The fact that neither $(CN)_2$ nor HCN absorbs these bands—both are colourless—may also be noted in favour of CN. Also, the presence of H_2 in the arc, causing HCN formation, *diminishes* the intensity of the CN bands.
[7] Cf. refs. in Abegg, "Handbuch der anorg. Chemie."
[8] Lewis and Randall, "Thermodynamics" (McGraw-Hill Co., 1923), pp. 592-4. The existence of $(CN)_2$ at low temperatures must evidently be ascribed to a negligible decomposition rate.
[9] This is shown by the non-dissociation of $(CN)_2$ below 800° C., supported by the non-appearance of CN as a chemical entity at ordinary temperatures.
[10] Cf. A. Fowler and H. Shaw, Proc. Roy. Soc., 86A, 118 (1912). The appearance of the CN bands in comets, presumably at low temperatures (as in active nitrogen), may reasonably be attributed to the action of electron bombardment or high-frequency radiation on C- and N-containing compounds which may be present.
[11] There is considerable evidence of an analogy between CN and BO, both chemically unsaturated "odd molecules," and the Na atom. This will be discussed elsewhere. It may be noted here, however, that in all three cases there are nine electrons in addition to the nuclei and K electrons, and in all the resonance potentials are low.

Spectral Theory and the Origin of the Nebulium Lines.

THE fact that the so-called nebulium lines are found to be associated with hydrogen and helium lines only, has frequently been taken as an indication that these lines are somehow emitted by hydrogen or helium, although it has been a great difficulty for this hypothesis that terrestrial experiments always have failed to reveal the lines. The physical conditions prevailing in nebulæ are very probably characterised by exceedingly low density combined with the absence of nearly all possible sorts of disturbing influences, apart from a field of radiation which, however, in only a few cases can be comparable in intensity to that of faint moonlight. Similar conditions of low density may also be essential characteristics of the outer atmospheres of long period variables, of the solar chromosphere, and the upper atmosphere of the earth, in all places of which there appear spectral lines of unknown origin or under anomalous conditions of excitation.

If the suggestion is true that the appearance of the nebulium lines, etc., is due to absence of disturbing influences, atomic theory would suggest that these lines were connected with a faint metastability of certain possible quantum states of the atoms which, under ordinary experimental conditions, is so small that it is broken down by interaction between the molecules in the gas or by the electric current applied. As to *hydrogen* in an atomic state, there appears to be no possibility left open for emission of lines which do not fit into the ordinary Balmer formula. It is, however, of great interest in this connexion that the 2_1 state of the hydrogen atom is exceptional as regards stability, as the transition $2_1 \rightarrow 1_1$ to the normal state is excluded by the selection principle. The stability of this state depends upon the fact that the relativity modifications in the motion of the electron are equivalent to the existence of a small additional central field necessitating the introduction of the azimuthal quantum number k and restricting transitions to such where k changes by $+1$ or -1. If the 2_1 state really possesses some metastability in hydrogen it must be the case to an enhanced degree for helium atoms with one electron only; and similar cases are to be found for the $2S$ term of the parhelium spectrum as well as for other spectra. (Cf. the calcium spark spectrum.)

Ordinarily, we expect that, in any recombination process between a positive ion and a free electron, the ion will in the overwhelming number of cases be in a normal stable state, while the outer electron occupies successive quantum states of the atom. For the special case in which the ion possesses metastable states, as is expectedly the case in helium, the binding process may perhaps take place to a large extent while the

atom, apart from the outer electron, still persists in a higher quantum state. In the special case of helium, we should thus expect that a free electron might be bound while the inner electron resides in a 2_1 quantum state. The spectral lines emitted in such a hypothetical binding process would be different from any lines or combinations in the ordinary helium spectrum and would just constitute a characteristic spectrum emitted by helium under conditions of a strong ionisation and excessively low density.

It would thus appear that the theoretical possibilities of the nebulium spectrum being due to helium are not yet exhausted. The possible existence of a metastable state of hydrogen would further help materially in understanding how hydrogen can show a marked degree of ionisation under the very feeble conditions of excitation in nebulæ, a fact which is evidenced by a marked emission of continuous radiation at the head of the Balmer series observed in several planetaries. This fact and the concordant complete absence of any trace of the hydrogen many line spectrum seem also to offer difficulties to all theories ascribing the nebular lines to molecular compounds of hydrogen and helium, an idea which otherwise would be in harmony with the above trend of thoughts. (Cf. H. H. Plaskett, NATURE, Sept. 15, 1923, p. 392.)

S. ROSSELAND.

Mount Wilson Observatory,
November 8.

Polarisation of the Light of Rainbows.

IT is quite well known that the failure of Brewster's law in the case of several substances is due to unavoidable imperfections in the polish of the surfaces. Several years ago the late Lord Rayleigh showed, by mechanical separation of surface impurities of water kept in a long metal trough, that Brewster's law did hold good in the case of water treated in this way.

On the morning of August 29, 1924, at about 6.15 A.M., when the sun was about 5° above the horizon, a strong primary bow attended by its strong secondary with the usual colour sequence was thrown on the westward sky. Just before the appearance of these bows, there had been one or two heavy showers, and during the interval the bows were visible it was almost incessantly drizzling. When examined by a nicol, light from the bow appeared almost completely plane polarised. Assuming, then, Brewster's law, and taking 1·33 as the refractive index of water for the mean ray, we find the angle of incidence is 53° 4′ and angle of refraction into the raindrop is 36° 56′ approximately. For one internal reflection, *i.e.*, in the case of a primary bow, we can calculate the total amount of deviation which the incident ray suffers. It is 138° 24′, which is about the same as that calculated in the usual manner. Now the raindrops taking part in the production of bows are for obvious reasons free from surface contaminations, and thus the above observations appear to confirm in a novel way the late Lord Rayleigh's suggestion that in the case of ordinary water, the failure of Brewster's law is due to the attendant surface impurities.

While the above observations were being made, a fresh bow parallel and close to the primary was suddenly developed. This had the same colour sequence as the primary but differed from the latter in intensity of colour and radius. The colour intensity, as judged visually, was slightly less, and the radius slightly greater, than that of the primary bow. But the most noteworthy phase of this phenomenon was that the new bow gradually approached the primary and ultimately merged into it. The whole phenomenon took about two minutes for its completion. The light from the new bow as well showed almost complete polarisation.

So far as I am aware there is no previous record of such a phenomenon, and consequently it is likely to excite much interest and explanatory speculation. So far as I know, the two primary bows may be explained by imagining two parallel rain showers from two gradually approaching clouds until one disappears into the other. A simple qualitative laboratory experiment with glass spheres filled with water, and a strong and steady source of white light, appears to lend support to such an explanation.

I should be much obliged if any reader of NATURE would kindly communicate to me any observations he may possess regarding the phenomena described above.

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An Endotropic Fungus in the Coniferæ.

DURING an investigation on the anatomy of the buds of the Coniferæ in 1923, certain features met with suggested the possible presence of an endotropic fungus in the living tissues, but the feature seemed so unlikely that the matter was not then further pursued. Researches on the distribution of potassium in the tissues of *Picea Canadensis* last year, by Miss E. S. Dowding in this laboratory, again brought to light features suggesting the presence of fungal hyphæ in the bud, and showed with certainty the presence of an endotropic mycorhiza in the deeper living tissues of the root. The inquiry was taken up again in the latter part of October, and since then I have found a fungus present in the living cells of the root, stem and bud in the following tissues: phelloderm, cortex, medullary rays, pith and cortical tissues of the bud.

The mycelium may be present as an exceedingly fine system of threads which are seen to penetrate the cell walls and may be massed in convolutions round the nucleus of the cell; they may be present as short jointed threads nearly filling the cells of the young root, and in certain tissues of the bud the hyphæ may assume the condition of large coiled threads frequently applied to the nucleus of the cell. Many of the stages in different tissues strongly resemble the various conditions of the mycorhiza of *Thismia Aseroe* described by Groom (*Annals of Botany*, 1895). An endotropic fungus penetrating the living cells of the root, stem and bud has been found during the last few days not only in *Picea Canadensis* but also in *Larix Laricina*, and I have good reason to suppose that a similar condition also occurs in Pseudotsuga and Abies. That such a condition of symbiosis, possibly obligate, should be present in some and probably a large number of genera of Coniferæ on this continent is surprising and opens up an extensive field of extremely interesting investigation.

During the last few days an examination of the root and stem of *Ledum palustre* and *Vaccinium Vitis-idæa* from this district has been made, and an endotropic fungus has been found similar to that described by Rayner (*Annals of Botany*, 1915) in European material. An account of the leading features of the coniferous material will be published immediately, and a more detailed paper dealing with the possible infection of the seed and other matters will be published later.

FRANCIS J. LEWIS.

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November 12.

Molecular Dimensions of Celluloid.[1]

RECENTLY we have had occasion to make thin films of celluloid by the previously known method of dissolving the celluloid in amyl acetate and allowing a single drop of the solution to fall on a clean water surface. With solutions sufficiently dilute, as the amyl acetate evaporates interference colours appear in practically uniform sheets of colour over the entire surface which change from red to violet and then the film becomes colourless. Some of these films were deposited on optically flat glass and their thickness determined by an interferometer method by C. G. Peters, of the Bureau of Standards' staff.

In this manner films so thin as 30 angstroms were measured. The solution from which these were deposited contained one gram of celluloid dissolved in four hundred grams of amyl acetate. Thinner films than these could not be measured directly, but those made from a solution containing one gram of celluloid in eight hundred grams of amyl acetate were sufficiently tenacious to hold together and adhere to the finger. With still further dilution—one gram of celluloid in twelve hundred grams of amyl acetate—as the last traces of the amyl acetate evaporated, a vibration or quiver was seen to pass over the surface of the water and the film simultaneously broke into minute particles of celluloid.

Assuming that the films decreased in thickness in proportion to the dilution of the solutions, since their area remained practically constant, this means that the films which were just too thin to hold together were approximately 10 angstroms thick. This value agrees with that calculated directly from the density of celluloid, the concentration of the celluloid solution and the area of the film on the water surface. Since the thinnest stable films must have been at least one molecule thick, these experiments indicate that the molecular complex of celluloid is not more than 10 angstroms in diameter. This value is in accord with similar results obtained on oil films[2] and other organic substances.[3]

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FRANKLIN L. HUNT, Physicist.
Bureau of Standards, Washington, D.C.
November 4.

Mercury and Helium.

IT is known that under some conditions not clearly defined or understood, mercury and helium may become so intimately associated that the separation of the one from the other is difficult. According to prevalent views, helium is a highly inert gas, and is therefore incapable of combining with other elements; hence it appears that helium can in some way not known act as a "carrier" of mercury.

For some years past I have been experimenting with mercury and various gases, including hydrogen and nitrogen. The results obtained led me to try similar experiments with mercury and helium; these last are now almost concluded. Briefly, the findings are as follows. Under certain conditions and in the presence of an electric glow discharge, mercury and helium combine to form mercury helide. The helide is a stable compound, and is not readily decomposed except at or above a bright red heat. As the formation of the helide progresses, a corresponding decrease in the volume of the helium employed takes place. On heating the mixed gases (helium and helide) to the required temperature, the original volume of the helium is restored. The helide is but slightly absorbed by charcoal cooled in liquid air. The refractive index of the mixture of helium and helide, as observed by a Jamin interferometer, increases continuously during the formation of the compound. When used in a vacuum tube of the form employed for spectrum analysis, mercury helide is gradually resolved into its elements. At the moment of activating the coil, the mercury green line (W.L. 5460·7) is invisible; then as the coil is worked, the line, at first faint, steadily increases in strength, and in some cases ultimately becomes quite bright.

Judging from these results, it appears almost certain that the associated mercury detected by earlier observers, has been present as helide, the conditions having been those under which that compound could be formed.

I have not yet carried out a quantitative analysis of the mercury helide, but a plan for doing so has been made, and is now being perfected. I hope shortly to give a detailed account of my work and conclusions.

J. J. MANLEY.
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November 19.

Optical Separations and Atomic Numbers.

IT has been recently shown (Millikan and Bowen, *Phys. Rev.*, 24, 1924) that in optical spectra due to atoms having similar electronic configurations, the doublet and triplet separations vary according to the relativity X-ray formula:

$$d\nu = K(Z-s)^4$$

where $d\nu$ is the doublet (or triplet) separation, K is $(0{\cdot}365 \times 2^3)/n^3$, n being the total quantum number appropriate to the orbits giving rise to the separation, Z the atomic number, and s the screening constant, which varies, becoming smaller, for example, in passing through Li I, BeII, BIII, CIV.

This formula has been applied to doublets and triplets generally, and the values of s obtained tabulated. On plotting curves it is found that the values of s within the same group are directly proportional to the atomic number, this proportionality holding also for the ionised elements. Moreover, the slopes of the graphs are very nearly the same for all groups. So far, straight lines have been obtained for groups I*a*, II*a*, II*b*, III*b*, II*a* spark, II*b* spark; others are being investigated. This linear relationship should be of importance in assigning spectral series; and it is being applied in this way. The matter will appear shortly in more detail.

A. C. MENZIES.
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November 19.

Eolithic Ornament and Art.

IN the English translation of Prof. Hugo Obermaier's book "Fossil Man in Spain" (Yale University Press), just published, there appears, on page 9, the following statement. "But some—among them Boucher de Perthes, Dharvent, . . . and J. R. Moir, went further, and proclaimed the existence of Eolithic ornament, and art."

This, so far as I am concerned, is entirely incorrect. I have never "proclaimed" a belief in the existence, in any form, of Eolithic ornament and art, nor do I believe that evidence which would make such a belief inevitable has, as yet, been discovered.

As Prof. Obermaier's book will, in all probability, be widely read by English readers, I regard it as necessary to make the above correction.

J. REID MOIR.

[1] Published by permission of the Director of the Bureau of Standards of the U.S. Department of Commerce.
[2] Lord Rayleigh, *Phil. Mag.*, 48, 331 (1899).
[3] Langmuir, Irving, Journ., Am. Chem. Soc. vol. 39, p. 1858 (1917).

The Carbon Atom in Crystalline Structure.[1]

By Sir WILLIAM BRAGG, K.B.E., F.R.S.

IT is one of the great purposes of research to be able to explain the properties of materials in terms of the properties of their parts. The division into parts may be carried to various degrees of fineness; and the nature of the research, its methods and difficulties, and the expectations of success will depend on the division that is attempted. The properties of a piece of steel may to some extent be explained in terms of the small visible particles, crystalline or not, of which it is composed; the degree of division is determined by the power of the microscope, and results of great value are obtained within this range. But we may have, as a higher ideal, the hope of explaining the qualities of steel in terms of the properties of the atoms of iron and carbon and other constituent elements. This division is far finer than the other; but obviously far more complete and satisfying. The difficulties are great, but so also will be, we may be sure, the ultimate success. Generally it must be our aim to explain the properties of all materials in terms of the atoms, remarkably limited in kind, of which the world is made.

Some progress towards the ideal has been made in the case of the gas and the liquid states; the great effort is yet to be made in the case of the solid. The moving particles of a gas are free from each other's influence for the most part of their time; they can be treated as projectiles the rare encounters of which are but slightly affected by the special and peculiar attractions which they exert on each other when very close together. The properties of gases are to a certain extent explainable in terms of a pure kinetic theory. Complications arise when from any cause the times during which the atoms or molecules are under each other's influence become relatively important, and the consequences depend on the individual peculiarities.

So also in the case of liquids much can be explained on a purely hydrodynamical theory, especially when the ties between atoms and molecules can be dissolved and re-formed continually without waste of energy in the form of heat, that is to say, when there are no viscosity effects. But when viscosity is to be taken account of, then the peculiar and individual actions of the atoms and molecules must be treated as effective. Still more, the phenomena of surface tension are direct manifestations of the forces that the atoms exert on their neighbours; and so in general are all the effects studied by the physical chemist. We are yet very far from being able to unravel them.

It is true that the associations and dissolutions of chemical action are due directly to the characteristic forces exerted by the atoms; and that chemical studies afford a most important means of examining them. Nevertheless, we want more than chemistry gives us if we are to reach our object. For example, we are far from linking up the properties of quartz with the known chemistry of silicon and oxygen.

In general, we know very little of the relation between the properties of the solid material and of the atoms of which it is built. Of the relation between the molecule and its constituent atoms we do know something, thanks to chemical study. But the wide field of solid structure is in this respect almost unexplored. The reason for this is very simple. The properties of the solid depend upon the structural arrangement of its component atoms, and the arrangement is, at the first attempt, as we may say, crystalline. When groups of atoms or molecules associate and form a solid, they arrange themselves in a regular pattern; the unit of pattern containing only a few groups, usually two, three, four, six or other small numbers. The arrangement is so uniform and so exact as to imply that the group has a definite and characteristic shape, or, in other words, that the forces which one group, atom or molecule exerts on its neighbours are such as to place them at proper distances from itself, and in proper orientations. The crystal is the direct expression of this tendency and is a far more prevalent form of matter than we had thought. The large crystals that we see with our naked eye, and even the small crystals which the microscope reveals to us, are only the favourable cases. Below all that we can see in any way is a universal tendency to crystallisation which the methods of X-ray analysis are now showing to us. The solid which appears to us to possess none of the properties of the crystal is usually a very viscous fluid, or a disordered mass of minute crystals. The crystal is the simple body, the so-called isotropic body is the complex. Consequently, it is the crystal that must first be mastered.

It is only within the last ten years that the direct study of crystal structure has been possible, and the way to this huge field of inquiry been thrown open. The X-rays, to put it simply, if somewhat crudely, are a form of light ten thousand times finer than visible light, and we are now able to see, indirectly it may be, the actual arrangement of the atoms. Here is our chance of making this supreme analysis. We have before us a widespread research, in the course of which we must examine crystal after crystal, learning its structure, that is to say, the pattern according to which its constituent atoms are arranged, and examining the way in which the properties of the individuals determine that pattern; and in turn the pattern determines the elasticities, rigidities, conductivities, dielectric capacities and every other characteristic which the crystal possesses. After that, follows in its turn the crystal conglomerate, the isotropic solid.

An especial interest is attached to all that we can discover by the new methods of crystal analysis concerning the nature and properties of the carbon atom. It is not one of the more common elements. While oxygen is calculated to form half the materials of the earth's crust, silicon a quarter, and aluminum about a sixteenth, only about a thousandth is composed of carbon. But it is the carbon atom which more than any other impresses its character on the materials of which living bodies are composed. The very term, organic chemistry, which is given to the subject that is largely occupied with the study of the carbon compounds, is an expression of the importance of the carbon atom in the living organism. Not only is the carbon

[1] Address delivered at the University of Pennsylvania, on September 18, on the occasion of the celebration of the centenary of the Franklin Institute. Reprinted, with slight modifications, from the Journal of the Institute for November 1924.

atom of supreme importance in the constitution of our bodies and of their unconscious actions, but also in a great proportion of the external activities in which we are engaged. We must be especially eager to know what we may learn of the behaviour of the carbon atom when it takes part in the constitution of the solid body, and in the first place of the crystal which is the simplest form of the solid. The only fact which makes us hesitate is the vastness of the number of known crystalline compounds, giving us a bewildering choice of material on which to work.

We come to this study with certain expectations founded on the large labours of the organic chemist and their rich harvest of results. We expect the carbon atom to display, for example, a definite tetravalency, a power of attracting to itself under certain circumstances, at least four other atoms and no more, all bound in a similar way to the central carbon; as, for example, when the carbon atom draws to itself four atoms of hydrogen and the methane molecule is formed. Yet, in other circumstances, the carbon atom seems fairly content with a smaller number, as when in the benzene ring each carbon is attached to two other carbons and only one hydrogen, and the benzene molecule has very little general attraction for another benzene molecule. Again in the carbon dioxide molecule, the carbon atom is satisfied by the companionship of two other atoms only, and we should like to know what rearrangement has been made of its activities to permit the formation of this self-contained molecule, so independent that it forms a gas. Also, what further change has been made when the molecule of carbon monoxide is constituted? In other words, what is the explanation of the single, double, and triple bonds known to the chemist? We hope to be able to throw light on all these conditions, and the questions to which they give rise, by the study of the carbon atom as it is built into the crystal, where we can examine the exact nature of its environment and can relate thereto the properties of the crystal.

There are two crystalline forms composed of carbon alone, diamond and graphite, and we naturally turn to their examination first. The diamond structure was, in fact, one of the first to be examined by the new methods. Its structure is very simple and symmetrical, and answers at once our expectation that we should find in some circumstances a perfectly tetravalent behaviour. Each carbon atom is surrounded by four others, which are grouped about it in perfect symmetry; the atom shows no attraction for more than four. A sphere can, of course, be surrounded by twelve other similar spheres, and if the attraction between any two atoms could be represented merely by a central force, we should expect the close packing which gives the full quota of neighbours. Since there are only four, the force exerted by one carbon atom on another cannot be represented by central forces only. Further, the hardness and rigidity of the diamond show us that the forces are mutually oriented; that they are primarily exerted along four lines drawn from the centre of a tetrahedron to its corners and that there is a strong resistance to any relative change in those directions. All these new points are in excellent agreement with known chemical facts. The carbon atom is to be represented by a tetrahedron rather than a sphere.

The disposition of the atoms in the diamond shows that they may be divided into two classes, any member of one class being the reflection of the other—with appropriate shift—in any one of three planes which are the cube faces of the crystal. To put this in another form, each diagonal of the cube crystal passes through the vertex and the middle of the base of each class of atom, but members of the two classes face opposite ways. The X-rays detect the difference between the two kinds, from which we conclude that the scatterers of the X-rays participate in the tetrahedral grouping. Yet the difference is only slight, so that if it is the electrons that scatter, they are close to the centre, which seems unlikely; or else they have an extended movement about their average positions at the corners, so that their diffracting effect is small; their action is like that of broad faint rulings on a diffraction grating.

The other crystal of pure carbon is graphite. There is no clear evidence at present of the existence of any other form, although certain curious carbon materials have not been fully examined. The structure of graphite has recently been re-examined by Bernal, who was able to obtain single crystals of sufficiently perfect form. The results of his work show that graphite is a hexagonal crystal, as Hull had supposed from an examination by the Lowder method. It consists of layers of carbon atoms, each layer separated from the next by 3·40 Å.U., as has long been known. In each layer, the carbon atoms are arranged in a hexagonal network; the long uncertain point as to whether the atoms of one sheet are all exactly in one plane or are in two planes making a puckered network, seems now to be decided in favour of the former alternative, as Debye has suggested. In this case, each carbon atom is very strongly tied to three neighbours, all in one plane; the distance between the centres is 1·44 Å.U. as against 1·54 Å.U. in the diamond. The distance between a carbon atom in one layer and its nearest neighbour in the next is more than twice as great.[2] The curious properties of graphite show that the forces between atoms in the same sheet are exceedingly strong, while the forces between sheet and sheet are very small. It is clear that the carbon atom is now exerting its attraction on other atoms in quite a different manner from that which was followed in the diamond. If the electrons are in some way responsible for these forces, their arrangement must have been altered. The atom is no longer tetrahedral.

The extraordinary success of Bohr's theory in regard to radiation is a constant inducement to attempt a correlation between his arrangement of electron orbits with the display of the atomic forces, although it does not seem possible at present to make more than vague and preliminary attempts in this direction. According to Bohr, there are four electron orbits which we may naturally associate with the tetravalency of the atom; but the four are not all alike, being different, two and two. Thus the tetravalency is not fully symmetrical. The radiating carbon atom which is the subject of the theory is not, however, attached to other atoms, but is free; and we may well suppose that the internal

[2] Since this was written, a paper by Hassel and Mark has appeared in the *Zeitschrift für Physik*, describing experiments which lead to exactly the same result as that of Bernal. The latter's paper appears in the Proceedings of the Royal Society.

arrangements are modified by structural requirements. There may be a real difference, implying perhaps a different energy content between the free atom with its two pairs of outer orbits, the atom in graphite with three like orbits and one odd, and the atom in diamond with all four alike. The electron of the odd orbit in graphite would naturally travel far and be loosely attached to the nucleus; and in this, as has been suggested by Shearer and Bernal, we may find the explanation of the colour, the opacity, and the conductivity of graphite.

We now come to cases in which other atoms beside the carbon enter into the structure; and first to calcite. The X-ray analysis shows that the carbon atom is now surrounded symmetrically by three atoms of oxygen, all alike.

The compact group of one carbon and three oxygens possesses a double negative charge; the calcium atom possessing the corresponding amount of positive electricity. It has been suggested by Kossel that the arrangement is governed by the tendency for the oxygen atoms to surround themselves in each case by the full complement of eight electrons, and that this is effected by stripping the calcium atom of two electrons and the carbon atom of four. On this theory, there is no parallelism with the graphite structure, though in both cases the carbon atom is surrounded by three other coplanar atoms, similarly situated. The carbon atom has now lost all four of the electrons that were moving in outer orbits and is reduced, in external appearance, to helium. It is to be treated as exerting a central electrostatic force due to a positive charge of four units.

It is well known that a vast number of organic substances are based on a substructure consisting of a ring of six carbon atoms, or a chain of carbon atoms of any length. The simplest ring compound is the famous benzene molecule; benzene does not, however, lend itself very readily to analysis because benzene is liquid at ordinary temperature and when frozen does not form good crystals. But there are the two substances, naphthalene and anthracene, of which the former has been imagined by the organic chemist to consist of a double ring, represented by two hexagons in the same plane, having one side and two corners in common. The latter consists of three hexagons in a line, the naphthalene model extended by one more hexagon. Both these substances crystallise well, a very marked characteristic of each being the tendency to split into thin flakes. All these molecules are bounded by hydrogens. They must be considered as simple subjects for attack, because the ring is so common a feature of organic substances, and the single, double and triple rings form a series of comparable members. A curious point of obvious interest is the connexion of each carbon atom with three, and only three, other atoms. Why has the fourth bond apparently disappeared?

The X-ray analysis shows that the unit of pattern of both naphthalene and anthracene contains two molecules arranged so that their long axes are parallel to one another and that they are the reflection of each other in the single plane of symmetry which the crystal possesses. In fact, the crystal can be considered as a set of parallel flakes, like the monomolecular layers of Langmuir. In each flake the molecules stand not quite at right angles to the flake, but lean over like wheat in a field blown by the wind. The difference between the anthracene and the naphthalene structures lies only in the length of the molecule, which makes the flake thickness of the former greater than that of the latter. Moreover, the actual increase in length which is found by the X-ray measurement is exactly what it should be if, in the first place, the one molecule consists of three benzene rings in a row and the other of only two, according to chemical theory, and in the second place, the width of the ring is the same as that of the carbon ring which is found everywhere in the diamond structure. We might suppose, in fact, that the molecule of naphthalene as built into the crystal structure was simply carved out of the diamond without alteration and then fringed with hydrogen atoms. A similar set of atoms carved out of the graphite flake would do equally well so far as length is concerned, because the graphite layer is, according to Bernal, the diamond layer pressed flat without any sideways extension. But if the carbon atoms were in the supposed graphite condition, it might be expected that naphthalene would be a conductor and be opaque like graphite, which is not the case. The direct analysis itself is not yet able to say whether the three attachments of each carbon atom to its neighbours in the same molecule are all on one plane. It is to be remembered that there are attachments between each molecule and its neighbours in the same layer, but these must be far weaker than the bonds binding together the atoms in the same molecules; they are stronger, however, than the end-to-end attachments which break on the cleaving of the crystal. These last must be feeble because the crystal cleaves so easily.

So far, therefore, the result of the analysis of these crystals is, in the first place, to give confidence in the existence of a mutual support between the established organic chemistry and the new methods of analysis; and to show us also how closely the behaviour of the crystal may be connected with its general structure. As to details, the indication seems to be that the carbon atom has—at least nearly so—the same characteristics as the atom of the diamond; but that one of the four valencies is unused. We have even some grounds for saying that the unused valency, or the unoccupied corner of the carbon tetrahedron, is that which lies on the face of the molecule, not on its edge. The crystal of naphthalene tetrachloride, *i.e.* naphthalene with four added chlorine atoms, shows the same structure as that of naphthalene, and has very similar dimensions except that it has broadened by an amount which would correspond closely with the result of adding the chlorines at the places indicated.

Measurements have been made of some of the dimensions of other crystals containing ring molecules, and the results fit in, so far as they go, with the idea that the ring is an actual structure of definite dimensions and form, slightly altered it may be by additions or substitutions of other atoms or groups of atoms, or strained because it has to be fitted into its place in the crystal, nevertheless recognisable in its different circumstances, as the chemist would expect. To settle these points more satisfactorily, to turn guesses into certainties is, of course, the work that is before us.

Very interesting results are obtained by Müller and

hearer from the study of the long-chain molecules of he fatty acids, hydrocarbons, and similar substances. t appears that when these substances in the solid tate are pressed on to a flat surface, they form flaky rystals like graphite or naphthalene, and it becomes asy to measure the thickness of the monomolecular ayer. The experimental results are beautifully definite, nd their interpretation can be given with great chance f being correct. It seems probable that the molecule s perpendicular to the layer, not slanting. If it were he latter, one would expect the amount of slant to be ariable so that it would not be possible to connect he thickness of the layer with the length of the nolecule only. Now, it is a remarkable fact that the hickness of the layer grows at a uniform rate as the hain is increased by the addition of carbon atoms, and hat for very nearly all, if not all, the different kinds f chain molecules that have been examined, this rate has one or other of two values. For every two carbon atoms that are added the increase in length is either 2·50 Å.U. or 2·00 Å.U. very nearly.

If we were to suppose that every carbon atom in the chain had four points on it, disposed like the corners of a regular tetrahedron, at any one of which an attachment could be made to a neighbour, in other words, if we supposed the atom to be as in diamond, then a chain of carbon atoms would take one or other of three forms, one of which is a screw. Putting the distance between the centres of two carbon atoms equal to the distance found in the diamond, namely, 1·54 Å.U., it can readily be calculated that the length of chain *A* (Fig. 1) is 2·50 Å.U. for every two atoms

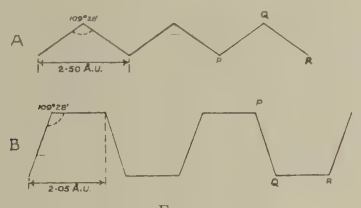

FIG. 1.

added, and of chain *B*, 2·05 Å.U. The agreement with experiment seems to be more than a coincidence, and it may be provisionally assumed that in these chains either the *A* or the *B* form is adopted, and the linkage of carbon atoms with their neighbours is on the diamond plan. In other words, if *PQR* are the centres of three atoms, the angle *PQR* is equal to the angle between two of the lines joining the centre of a tetrahedron to the corners.[3]

One of the most striking results is the fact that the length of the main body of the chain is independent of the nature of any additions to its ends or replacement of any of its side hydrogens by an oxygen atom as in the ketones. Even the removal of two or four hydrogens from the body of the chain leaving two carbons connected, respectively, by a double or a triple bond, makes no appreciable difference in the length. It would not have been a matter of surprise if such treatment had caused a bend in the chain, on account of the relative shifting of points of attachment on the carbon atom that might be due to other points of attachment being unused. The removal of a pair of hydrogens from the chain makes no more difference to the chain than the stripping of an opposing pair of leaves from the stem of a plant.

A very curious point in the behaviour of the long chains is their apparent doubling in length when one end is formed of a so-called active group, as, for example, in the case of the fatty acids. When this is the case two chains join end to end, the active groups being together, and again the result is just the same as if two sticks were joined into one, the process of joining being concerned with nothing beyond the two active ends. This form of structure is illustrated in a very interesting way in the X-ray spectra. If a section is made of a substance consisting of layers of these doubled molecules, so as to show their stratification, then there will be a uniform distribution of diffracting centres—electrons—throughout the mass, with alternating thin layers of excess through the active ends, and thin layers of deficiency through the inactive ends, the methyl groups. This has the curious effect of intensifying the odd orders of the diffraction spectra. To understand this, it is only necessary to remember that if we were to make a series of fine rulings on a diffraction grating which exactly interleaved the stronger original rulings, the result would be the strengthening of the even orders; such an effect is found in the case of rock salt and was an important help in the determination of its structure. If now the additional rulings, instead of being like the original but weaker, could be of reversed effect, a deficiency instead of an excess, it would be the odd, not the even orders that would be strengthened. The same effect is found in the case of the ketones. When the substituted oxygen is in the middle of the chain, each layer of hydrocarbon molecules shows a generally uniform distribution of electrons with an excess at the middle where the oxygen atom is placed, and a deficiency at either end. When the substituted oxygen is not in the middle, the reinforcement of the odd orders disappears.

These many observations of the behaviour of the long-chain molecules seem to point to the conclusion that the carbon atom in the chain is, like the carbon atom in the diamond atom, possessed of four points of attachment regularly disposed about it, and that the non-use of one does not alter the disposition of the others.

It is scarcely necessary to consider in any detail the points given by structures like tartaric or succinic acid as to the behaviour of carbon atom. It is enough to say that, while the full interpretation may be yet to come, the general indications are in accordance with what has already been said.

These first tentative conclusions as to the behaviour of the carbon atom in the solid body are of interest, in spite of the fact that so little, relatively, has been accomplished in the solution of the structure of organic crystals. What remains to be done must have great consequences, and what little has been done already seems to possess many points of novelty and of interest, and these two facts taken together may be sufficient justification for this attempt at a review of the present position of the inquiry.

[3] A minute but perfect crystal of stearic acid has recently been examined by the X-ray method by R. E. Gibbs, who has found it to belong to the monoclinic class. The long molecules are not perpendicular to the cleavage plane, but are inclined at about an angle of 63°. This result is not necessarily in contradiction with any of the above suggestions.

The Biology of the Suez Canal.

THE Cambridge and Royal Society Expedition which set out last September to investigate the biology of the Suez Canal (see NATURE, October 4, p. 520) arrived at Suez at the end of the month, and at once went under canvas on the shores of the Bitter Lakes, being provided with boats, etc., by the generosity of the Canal Company. Here the members remained for four weeks, afterwards proceeding to Suez for a like period. They are now at Ismailia living on a house-boat lent by the Canal Company, this being towed from place to place as desired. Later they propose to move to Port Said for the last four weeks of their stay.

The Bitter Lakes, which are about 36 kilometres long by 12 broad, becoming much narrower to the south, yielded surprising results. There is a central area of about 6 fathoms, that overlies an extensive salt bed. This is covered by black mud, which proved to be absolutely devoid of life, although the density and temperature of the water immediately over it are relatively little higher than elsewhere; it may be presumed, however, that the salinity of the Lakes must have decreased since the Canal was opened. This deeper ground merges into extensive areas of shallower waters (0-3 fm.) by the shores, the surrounding land being almost typical desert. The waters were investigated in 1882 by Keller, who found them almost devoid of life, while Fox now writes enthusiastically as to the richness and variability of the organisms of this shore region. Keller found no anemones or echinoderms, 1 species of crab, 2 sponges, and a very few worms, while Fox records anemones as very common, also a few alcyonaria, echinoderms represented by sea urchins, starfishes, brittle stars, and holothurians, many species of crabs and sponges, with an abundance of worms and representatives of most other groups of organisms, including excellent soles. Bare sand, almost devoid of life, is found in patches, but most of the bottom is covered with a rich growth of algæ and phanerogamic plants. There is a striking average increase in size of some of the individual species of animals as compared with those which Fox previously collected for research purposes at Suez, the most striking being a large black Synapta about 45 cm. long as compared with the usual length of 25 cm. There proved to be considerable diversity of fauna and flora off different shores of the Lakes, and contiguous patches of the bottom were often found to carry different plants and animals, so that the mapping out of the bottom regions proved a task of great difficulty.

"The salt pools on the shores," writes Mr. Fox, "although interesting, have been disappointing owing to the poverty of their fauna. All contain one fish and one gastropod, both species in great numbers. There is no plankton and no other animal. The fish and mollusc both feed on algæ. The surprising thing is the high salinity which the fish and mollusc endure. My hydrometer registers 1000 in distilled water, 1204 in saturated salt solution. The Red Sea off Suez is 1031, the Bitter Lakes 1035-1045. These fish and molluscs live happily in 1175." (These are relative figures that may require adjustment for temperatures, etc.)

At Suez the Expedition has been mainly concerned with collecting the fauna and flora for comparison with those of the Bitter Lakes. Exact data as to temperatures, salinities, acidities, etc., have been obtained. There would seem here to be greater variability in the bottom life as compared with the period antecedent to the opening of the Canal. For this reason the Expedition has confined its work to ten selected stations, mostly with soft bottom, only once having visited the "coral" reefs which lie about 3 miles to the south. The greater part is sand; phanerogamic plants are uncommon, and algæ almost absent. The latter, however, occur abundantly under the piers, and Mr. Fox discusses how far the general absence of algæ in the Gulf of Suez may be due to an inhibition produced by the intensity of light, the possibility of this as the chief factor being largely discounted by the strong growth of plants in the Bitter Lakes. The Expedition has also studied with great care the organisms attached to vessels, to piles, and to buoys, cleaned on known dates, and has put out wooden floats. These latter should give data both as to the factors helping in the distribution of the organisms and as to the rates of growth of many forms.

In his comparison of the two regions he has so far studied, Mr. Fox concludes that the fauna on the piles of piers is equally abundant, "but the shallow bottom and coast fauna is more abundant in the Lakes. It seems to me that the richer Lake fauna may depend on the bottom, which is mostly sand mixed with mud. On this the phanerogamic weed grows in abundance and gives cover to animals. Further, detritus feeders like mud. In the Bay of Suez, on the other hand, the shallow bottom is more often sand. There are small areas of sand in the shallows of the Bitter Lakes, and these are devoid of weed and very poor in animals, as at Suez. The difference in richness then may be due to a difference in bottom. The striking facts about the lakes would be that (1) the higher salinity does not prevent a rich varied fauna, (2) it does not inhibit growth in size, (3) there are peculiar effects, such as the sex of Neptunus, almost all males."

The work of the Expedition has clearly been much expedited and made far pleasanter by the kindness, generosity, and personal interest that has been taken in it, not by the directors alone, but by all the officials of the Canal Company. They have lent boats and camping equipment, carried mails and helped in the commissariat. The head of the Coast Guards has lent launches, and the officials of the Government have uniformly been friendly. The Canal Company clearly has an area under its control of great scientific interest, if periodically examined. The present Expedition can only, at most, map out its different faunistic regions, and it will remain for a further expedition to examine these quantitatively, so that science may get the full value of the present enterprise.

J. STANLEY GARDINER.

The Coming of Age of Mechanical Flight.

ON December 17, 1903, twenty-one years ago, the famous brothers, Wilbur and Orville Wright, made their first flights with a power-driven aeroplane. Model steam-driven aeroplanes had flown before, and there is some evidence of the partial success of Clement Ader's *Avion* in 1897. But the Wright brothers were the first human beings to rise in the air in a power-driven flying machine and to descend in safety. Altogether four flights were made on that memorable day in 1903, the first lasting 12 seconds and the last 59 seconds. There were only five spectators present on the sandhills at Kitty Hawk, North Carolina, when the flights were made, but there appears to be no question of the correctness of the facts. December 17 is, therefore, regarded as one of the most important dates in the history of mechanical flight and is known in the United States as Aviation Day.

The machine with which the remarkable feat was achieved was a biplane fitted with a petrol engine made by the Wrights. The engine weighed about 7 lb. per horse-power, and the total weight of the aeroplane was 750 lb. Prof. S. P. Langley, who had devoted himself to the scientific investigation of the problems of flight, ran the Wrights very close, and had his machine not been damaged when being launched at two trials made on October 7 and December 8 of the same year, the honour of building the first machine to fly with a human being aboard might have been his. It was Langley's early experiments, and his belief in the possibility of human flight, which were among the influences that led the Wrights to undertake the preliminary investigations that preceded their actual work.

The success of the Wright brothers was largely due to their thorough study of what had been done before, and the interest attaching to the twenty-first anniversary justifies a brief review of the history of the aeroplane. Foremost among pioneers must be placed Sir George Cayley, sometimes called the father of British aeronautics, W. S. Henson, and J. S. Stringfellow. Of the work of Henson and Stringfellow at Chard, in Somerset some eighty years ago, there are many relics in the Science Museum, South Kensington, while the Smithsonian Institution at Washington contains Stringfellow's engine of 1866. The inauguration of the Royal Aeronautical Society in 1866, and the holding of the first Aeronautical Exhibition in 1868, emphasised the growing interest in the subject, and these events coincided with the earliest experiments of Otto Lilienthal. The names of Le Bris, of Alphonse Penaud, and of Clement Ader belong to a nation which was to witness some of the most splendid flying exploits. Langley's work began in 1887, and the year 1896 saw the flight of his steam-driven model. To the 'nineties also belongs the wonderful gliding experiments of Lilienthal in Germany, Pilcher in England, of the veteran Octave Chanute in the United States, and of Capt. Ferber at Fontainebleau.

It was with a knowledge of what had been accomplished by these pioneers that Wilbur and Orville Wright began their work. Born respectively in 1867 and 1871, the Wrights as young men had a bicycle business in Dayton, Ohio, and it was there they turned their attention to gliding and flying. The summer of 1900 saw their first experiments on the Kill Devil Hill sandhills, which were repeated the two following years. In the course of these experiments, says Col. Lochwood Marsh, they "confirmed Lilienthal's theory of the reversal of the centre of pressure on cambered surfaces at small angles of incidence: they confirmed the importance of high aspect ratio in respect to lift: they had evolved new and more accurate tables of lift and pressure on cambered surfaces: they were the first to use a movable horizontal elevator for controlling height: they were the first to adjust the wings to different angles of incidence to maintain lateral balance: and they were the first to use the movable rudder and adjustable wings in combination." The three summers given to gliding were followed by three years' experiments on power-driven machines. In 1903 they made their first flight; in 1904, for the first time, a circle was completed in the air; and in 1905 Wilbur Wright flew a distance of 24 miles at 38 miles an hour, the first successful long flight.

Meanwhile, a band of devoted French pioneers, including Ferber, the Voisins, Farman, Blériot, and Delagrange, quite independently approached success, and on November 12, 1906, in the Bois de Boulogne, the Brazilian, Alberto Santos Dumont, made the first officially recorded flight in Europe. From this time on, record has succeeded record, inventions, investigations, and accidental discoveries have multiplied apace, and the small band of pioneers has become an army.

The fine flight of Orville Wright at Fort Meyer, U.S.A., together with the displays of Wilbur Wright at Le Mans in 1908, gained for flying a popularity hitherto unknown, and the following year saw Blériot cross the English Channel, Cody make the first flight in England, and the meeting of the masters of flying at the famous Rheims gathering. It was in 1910 that Paulhan and Grahame-White had their great struggle for the *Daily Mail* prize of 10,000*l.* for a flight from London to Manchester. Many casualties, however, had to be recorded in these early days, and among them were the deaths of the Hon. C. S. Rolls at Bournemouth, and of Georges Chavez, who on September 23, 1910, flew over the Alps in a Blériot monoplane, only to meet his death in the hour of triumph.

Two years later came the formation of the Royal Flying Corps, and in 1914 the aeroplane took its place on the battlefield as an engine of war. In August 1914 the British Air Services mustered 272 machines. Four years later there were more than 22,000 efficient machines, and new ones were being delivered at the rate of 90 daily. The advances made during the War were summarised by Sir J. E. Petavel in his address to the Bournemouth meeting of the British Association in 1919. Speeds had risen from 80 miles an hour to 140 miles an hour, and the engine horse-power in a single machine had been increased from 100 to 1300.

With the cessation of hostilities came the exploration of the possibilities of commercial flying. In May 1918 a mail service was started between Washington, Philadelphia, and New York, and 1919 saw the inauguration of the London to Paris service. The same year saw the crossing of the Atlantic via the Azores

of the American flying boat NC4, piloted by Lieut.-Commander Read, and the great flight by Alcock and Whitten-Brown in the Vickers-Vimy machine which has now passed into the possession of the British nation. To the same period belongs the feat of Godoy, who crossed the Andes at a height of 19,700 feet, and the first England to Australia flight by Ross-Smith and his brother and two mechanics. With continents and seas crossed in many directions, the circling of the earth was only a matter of time. To accomplish this, however, meant the expenditure of a large sum of money. Surveys had to be made, stores collected, and routes patrolled. Of Squadron-Leader Maclaren's glorious attempt, and the splendid achievement of Lieuts. Smith and Nelson, of the United States Navy, during the present summer, there is no need to write. It was in the United States that the aeroplane was born, and there can be no grudging of the United States her round-the-world-triumph in the year which sees its coming of age.

Current Topics and Events.

On December 13 occurs the bicentenary of the birth of the celebrated German natural philosopher, Franz Ulric Theodor Aepinus, remembered to-day for his "Tentamen Theoriae Electricitatis et Magnetismi," published at St. Petersburg in 1759. Born in Rostock, Saxony, Aepinus was descended from a leading theologian of the Reformation. After studying medicine, he devoted himself to mathematics and physics, and at an early age became a member of the Berlin Academy of Sciences. Like many other foreign men of science, he was attracted to the Russian capital, and became attached to the Imperial Academy of Sciences, inaugurated by Catherine I. on the plans of Peter the Great. Aepinus in 1757 was appointed to a chair of natural philosophy, afterwards became a tutor in the royal family, and endeavoured to found schools throughout the empire. In later years, like his great contemporary, Euler, he was patronised by Catherine II. He died on August 10, 1802, at Dorpat in Livonia, whither he had removed four years earlier. He wrote memoirs on mathematics, astronomy, optics, and mechanics, and in 1764 created great interest by a discussion of the transit of a planet across the sun's disc. Founded upon a modification of the single-fluid theory of electricity, his "Tentamen Theoriae Electricitatis . . . " has been described as the first systematic and successful attempt to apply mathematical reasoning to the subjects of electricity and magnetism. He also indicated the theory of the electrophorus, which, however, was constructed by Volta.

In the middle of the last century the name of Alexis Perrey of Dijon was scarcely less known as a student of earthquakes than that of his contemporary Robert Mallet. The annual catalogues that he compiled, his regional memoirs on earthquakes, and the three laws which he stated as governing the periodicity of earthquakes were widely known. Perrey was the personal friend of such men as Ampère, d'Abbadie, Cauchy, Elie de Beaumont, and Quetelet. Yet his death in 1882, only seven years after his last paper was printed, attracted little, if any, attention. The societies with which he was so closely connected published no obituary notices, and even the dates of his birth and death were unknown to those outside his own circle. After the lapse of forty-two years, this defect has been supplied by a long and interesting account of his life and work recently published in the *Mémoires* of the Dijon Academy of Sciences, of which Perrey was treasurer for nearly twenty years. A very full analysis of his work, with a complete bibliography of his writings, is contributed by M. E. Rothé, director of the central seismological office at Strasbourg. The biographical section is written by M. H. Godron, Perrey's grandson, and from this we learn that he was born on July 6, 1807, appointed lecturer in pure mathematics at the Royal College of Dijon, and professor of applied mathematics (an office created for him) in the Faculty of Sciences. In 1867, owing to ill-health, he retired, though he continued writing his seismological memoirs while at Lorient for seven or eight years longer. He died in Paris on December 29, 1882.

In reference to our note in the issue of November 8, p. 690, dealing with the origin of pearls, a correspondent writes that "about 300 B.C. Megasthenes, writing from somewhere about the middle of India, mentions the pearl fishing in the Straits of Manaar," but this is in reference to "the sea pearl called by the natives Margarita," and not to the possibility of a pearl in vegetable tissues. Megasthenes accompanied the Macedonian general, Seleucus Nicator, in his Asiatic campaigns about 307 B.C. Theophrastus (378–286 B.C.), pupil of Aristotle, but perhaps a greater master of science, specifically refers to them as coming from bivalve molluscs and as used for necklaces. Oppert translates a far earlier Assyrian inscription from Nineveh: "In the sea of the changeable winds his merchants fished for pearls; in the sea where the North Star culminates they fish for yellow amber"; pearls are also recorded as part of the tribute of the Chaldees. The Shoo King records that "the wild tribes about the Hwae brought oyster-pearls and fish" to the great Emperor Yu as tribute, 2205–2197 B.C.; these were probably pearls from freshwater mussels. Homer describes Juno as having "bright drops (τρίγκηνα) suspended from her ears," perhaps pearls, but probably golden drops. There is abundant evidence, however, of the use of pearls and pearl shell in all the ancient Eastern civilisations, and the Mahawansa records a gift of pearls and chanks (large-coiled marine molluscs found in the Gulf of Manaar) from King Wijayo (Ceylon) to his father-in-law before 500 B.C. Very beautiful are some of the beliefs about pearls, such as the concrete essence of the moon collected by the action of the negative principle in Nature (Giles's "Chinese Dictionary"), and the drops of rain falling into the open oyster shells and

concreting (Pliny), and these are equalled by the sixteenth century astrologer Cardan's theory that they are polished by being pecked and played with by doves.

THE policy of excluding Germans from international congresses is dealt with in an article in the November issue of the *Scientific Worker* by Prof. G. H. Hardy. In the course of his remarks, Prof. Hardy notes that at the International Mathematical Congress held at Toronto last summer, the representatives of the American Mathematical Society expressed their indignation at being summoned to the Congress without knowing that, according to the statutes of the International Research Council, German representatives were excluded. A resolution in favour of the removal of this ban was supported by the representatives of America, Denmark, Great Britain, Holland, Italy, Norway, Sweden, and Switzerland, but as it was contrary to the statutes it could not be carried. Unless the International Research Council itself removes the ban, the Union of Mathematics may collapse.

CAPT. KNUD RASMUSSEN, the Danish Arctic explorer, on his return to Norway from Alaska, gave some details, published in the *Times*, of his three years' journey of 20,000 miles from Greenland along the coast of North America. His object was to follow the route by which the Eskimo originally migrated westward, studying various tribes on the way. Parting from the other members of his expedition in King William land in April 1923, he met an Eskimo tribe called Netsilic, who were living completely in the Stone Age, and were in unceasing feud with tribes farther east. With some difficulty he succeeded in visiting the Netsilic settlements and gaining the confidence of the tribesmen. The exact locality of this tribe is not stated, but in this connexion Mr. Stefansson's recent discovery of the copper Eskimo in Victoria Land is of interest. Although Capt. R. Amundsen passed along much the same route in 1903–1905 as Capt. Rasmussen, the existence of white men is almost regarded as a myth by many tribes. In Alaska inland tribes of Eskimo were discovered. They have no knowledge of kayaks, but descend the rivers in large skin boats in order to buy blubber from the coast tribes. No language difficulty occurred until the Nunbaniut tribes, in the South Yukon district, were encountered. With them an interpreter had to be used owing to the wide divergence of their speech from the usual form of Eskimo. Capt. Rasmussen hoped to continue his researches in Siberia, but after crossing Bering Strait was forced to abandon the attempt owing to opposition by the Russian authorities. Large ethnographical and biological collections, as well as many cinematograph films, have been brought to Europe.

THE ship *Discovery* which is to be employed in research into whaling in South Georgia and the South Shetlands, and, incidentally, in scientific work affecting oceanography, meteorology, and magnetism, is still undergoing reconstruction at Portsmouth, and it is not likely that she will be commissioned for several months to come. If time permits, it is proposed that the *Discovery* should proceed to Stanley, Falkland Island, carrying out a programme of scientific observations on the way; and that from Stanley she should proceed to South Georgia, arriving there about the commencement of the whaling season in October 1925. Meanwhile a marine station in connexion with the expedition is being established at Grytviken, South Georgia. The building was constructed in sections in England to facilitate erection locally. Provision has also been made for a laboratory, and a considerable portion of the necessary scientific equipment has been shipped. Simultaneously with the erection of the marine station, a wireless station, and other buildings belonging to the Colonial Government, are being constructed under contract with the Marconi Company. The scientific staff at the marine station will consist of three zoologists and a hydrologist with a laboratory assistant, viz. *Zoologists*: Mr. N. A. Mackintosh (in charge), Mr. J. F. G. Wheeler, Mr. L. H. Matthews; *Hydrologist*: Mr. A. J. Clowes; *Laboratory Asst.*: Mr. A. Saunders. The officers of the expedition who have already been appointed are as follows: Scientific Officers—*Director of Research*: Dr. S. W. Kemp; *Zoologists*: Mr. A. C. Hardy, Mr. J. E. Hamilton, Mr. E. R. Gunther; *Hydrologist*: Mr. H. F. P. Herdman. Ship *Discovery* Officers—*Commanding Officer*: Lieut.-Commander J. R. Stenhouse; *Medical Officer*: Lieut.-Col. E. H. Marshall; *Chief Officer*: Mr. Ernest E. F. Letts.

PROF. P. F. FYSON, of Berhampore, Bengal, in a comment on the abridgment published in NATURE of August 30 of Prof. J. W. Gregory's presidential address to the Section of Geography of the British Association at Toronto, though agreeing that medical research has removed the old bogies of special tropical diseases, considers that in that address the effect of the unrelenting high temperature of the tropics was underrated. He believes, however, that the heat can be mitigated to a very considerable extent by the adjustment of clothing and habits. The European in India wears clothes of the same style as in his temperate home, whereas the Indian man, when not dressed to meet Europeans, wears nothing above the waist, or on legs and feet. According to Prof. Fyson, if the European is to stand tropical temperatures he must do likewise. His clothes reduce the cooling surface of the body to face and hands, and covering the rest by at least two layers of clothing interferes with the natural regulating action of the skin. He considers that women suffer more than men, chiefly because it is more difficult for them to discard undergarments. The chief reason for wearing European clothes is said to be Mrs. Grundy, who is assisted by Nature, as a hirsute white skin is not beautiful, and the white man is very sensitive to irritation by insects. Most men, even on a warm evening, wear boots or two pairs of socks at dinner to protect the ankles from mosquitoes. Prof. Fyson considers that to colonise the tropics successfully the white man, and still more the white woman, will have to throw off the idea that the naked hirsute skin is indecent, and be prepared to adopt some such dress as the Indian. They must

also, like the Indian, split each day into two, and work only in the morning and evening, resting in the middle of the day. These changes in dress and habit will only be brought about if public opinion be educated in the direction of rational dress for all occasions and for different climates. In reference to these comments, it may be remarked that Indian colleges work through the morning and afternoon without any long siesta, and though heat is doubtless the special characteristic of the tropical climate, it does not alone explain its unhealthiness, since specially hot tropical localities are often healthier than others with a lower temperature.

IN a new edition of a most important work on the textile fibres it is stated that "India is destroyed as a possible source of supply [of long staple cottons] for the English mills." This statement was rightly challenged in a review in these columns (September 20, p. 422), where it was hinted that such cottons are actually being produced in India on a considerable scale, and are eagerly bought up in Lancashire. A most important revival in the cultivation of better types of cotton is in progress in India, and, for this, great credit is due to the patient, untiring efforts of the Indian Central Cotton Committee. Hitherto, however, most of the agriculturists who have attempted the improvement of cotton strains in any part of the world have found it difficult to get their experimental products tested under mill conditions or graded on exact scientific data. The crowning achievement in India, therefore, is the foundation of a Technological Research Laboratory where this guidance may be secured to the grower. As director, the Committee has been fortunate to secure Prof. A. J. Turner, recently professor of textiles in the College of Technology, Manchester, and various Lancashire machinists have presented standard plant for an experimental mill. The foundation-stone of the Research Laboratory was laid on December 3 by the Viceroy of India, who also opened the experimental spinning mill.

A CORRESPONDENT writes in reference to the report on the "White Indians" found among the Chucunaque Indians of Panama by Mr. R. O. Marsh (*See* NATURE, Nov. 22, p. 761), to point out that this tribe had already been visited by Mr. F. A. Mitchell-Hedges and Lady Richmond Brown in the course of their expedition of 1922–1923. Mr. Marsh, on the other hand, did not reach the upper waters of the Chucunaque until the spring of 1924. Lady Brown recorded the occurrence among the Chucunaque of the albinos, whom Mr. Marsh described as "White Indians," in her book "Unknown Tribes: Uncharted Seas." It may be noted that although Lady Brown did not make a special study of the question, as did Mr. Marsh, her estimate that the albinos formed 10 per cent. of the population is identical with his. In this matter it would be difficult on either side to sustain a claim to absolute priority in view of the fact that the occurrence of white individuals in Darien was noted by the early Spanish voyager Vasco Nunez de Balboa and by the buccaneer Wafer in 1699, as well as by several later writers. Albinism is comparatively frequent among the Indians of America.

ON Friday, December 5, at the Junior Institution of Engineers, Mr. J. B. Polland gave a demonstration of metal cutting under water by the oxy-acetylene blowpipe. Mr. Polland stated that an oxidising and not merely a heating flame is used for cutting purposes. The centre of the jet of the blowpipe, therefore, consists of the actual cutting flame, while the envelope round that is more heating and yet of such a nature that its heat is dissipated more quickly in water. Round the whole of this jet is a further envelope of air which acts as an insulating medium between the flame and the water. To illustrate the fact that it is only the centre of the jet that really does the work Mr. Polland held his hand under water right in the more luminous part of the flame without ill effect. For general work the oxygen and acetylene are supplied under pressure from gas cylinders; the air or oxygen need not be pure or dry. The pressure required is determined by the depth of water at which the blow-pipe is used; the blow-pipe has been used in depths of 60 feet.

SIR JOSEPH THOMSON and Dr. W. C. Unwin have been elected honorary members of the Institution of Civil Engineers.

AN assistant chief veterinary research officer is required for Kenya. Applications for the post must be made upon a prescribed form obtainable from the Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1.

THE collections illustrating stationary engines and locomotives, belonging to the Science Museum, South Kensington, are once more accessible to the public. They have been transferred from the old galleries to new accommodation on the ground floor of the eastern block of the new museum building at South Kensington (Exhibition Road).

THE Huxley Memorial Medal for 1924 of the Royal Anthropological Institute was presented to Dr. René Verneau, of Paris, at a meeting of the Institute held on November 25. Before the presentation of the medal, Dr. Verneau delivered the Huxley Memorial Lecture, for which he had chosen the title "La Race de Néanderthal et la race de Grimaldi: leur rôle dans l'humanité."

THE South African Institute for Medical Research, Johannesburg, requires a bacteriologist, preferably a medical man with special experience in plague, for research work. He must be competent to prosecute original investigations and be willing to engage in field work. Applications for the post, with references to two scientific men, should be sent to "Bacteria," c/o The Director, Lister Institute, Chelsea Gardens, S.W.1.

THE Christmas Lectures for Young People arranged by the Royal Geographical Society will be given at 3.30 on December 29 and January 2 in the Æolian Hall, 135 New Bond Street, W.1, by Major R. E. Cheesman, on "Wild Life of the Arabian Desert,"

and Dr. H. R. Mill on "Some Explorers I knew." Written applications for tickets should be made to the Chief Clerk of the Society by December 20.

APPLICATIONS are invited by the Association of Producers of Nitrate of Soda in Chile for three posts in connexion with the central research department which the Association is to organise in that country. The positions in question are a directorship of research and two sub-directorships. Candidates should be chemists or chemical engineers of first-class scientific training and experience in the investigation, design, and operation of large scale processes and plant, and, if possible, between thirty-five and forty-five years of age. Applications should be made to the Secretary, The Chilean Nitrate Committee, Friars House, New Broad Street, E.C.2.

THE twelfth annual meeting of the Indian Science Congress will be held in Benares on January 12–17. His Highness the Maharaja of Benares, Sir Prabhu Narain Singh Bahadur, has consented to be patron of the meeting, and Dr. M. O. Forster, Director of the Indian Institute of Science, Bangalore, will be president. Communications should be addressed to Prof. S. P. Agharkar, General Secretary, Indian Science Congress, 35 Ballyganj Circular Road, Calcutta. The local secretaries for the meeting are Prof. L. D. Coueslant, Department of Engineering, P.O., Benares Hindu University, and Prof. K. K. Mathur, Department of Geology, P.O., Benares Hindu University, to whom all inquiries as to accommodation should be addressed.

THE issue of part 12A of volume iv. of the *Journal de Physique et Radium* completes the volume for 1923. The part contains a description of the apparatus and experiments of a physical character exhibited at the Grand-Palais on the occasion of the jubilee of the Société Française de Physique. Although short, these descriptions are to the point and well illustrated. The complete volume has nearly 600 pages devoted to original communications, and nearly 1200 to a bibliographical review of current literature, the subject and author indexes to which occupy more than 200 pages. In future each original communication to the *Journal* is to be preceded by a summary supplied by the author, as in the *Physical Review* and the Proceedings of the Physical Society of London.

THE Report of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne for the year 1923–24 is a record of valuable work, in many directions, in the interests of natural history, done in a quiet and unobtrusive way, with results which are bound to be of permanent value. The Society took its share in the negotiations which have resulted in the Farne Islands being purchased and vested in the National Trust as a bird sanctuary, and it is fitting that the Museum which owed its inception to John Hancock should have been the scene of the meeting at which this important scheme was inaugurated. The Museum of the Society is undergoing rearrangement, particularly as regards the geological department, and room has at last been found to start a botanical exhibition series. It is to be hoped that the appeal, which is so earnestly and moderately made for increased support, will meet with the deserved response, for the Society has a long and distinguished record behind it, and is doing most valuable work, not only in the Museum which it supports, but also through the activities of the energetic band of naturalists which it includes amongst its members.

Our Astronomical Column.

SKJELLERUP'S AND GRIGG'S COMETS. — Messrs. Crawford and Meyer were the first to suggest the probable identity of Skjellerup's Comet 1922 I. with Grigg's Comet 1902 II. They re-examine the question carefully in Lick Obs. Bull. No. 354. They made a new determination of the orbit of 1922 I., finding a period of 5·01894 years. Perturbations by the earth were applied from March to July 1922. The elements were carried back unperturbed until July 2, 1906, and the very large perturbations by Jupiter in 1905–1906 were carefully calculated. The result is not at first sight in favour of the identity of the two comets, as it makes perihelion in 1902 several months earlier than that of Grigg's Comet. But they add that a reasonable change in the period adopted in 1922 would largely modify the great Jupiter perturbations of 1905 (minimum distance 0·08). Moreover, there were appreciable perturbations by Jupiter about 1915 that have not been applied. It is fully demonstrated that the considerable change in the inclination and other elements from 1902 to 1922 is well within the possible amount due to Jupiter. The question will probably remain unsettled until the return in 1927, which will give an accurate value of the mean motion in 1922 and permit of a more accurate carrying back.

VARIABLE STARS. — The *Japanese Journal of Astronomy and Geophysics*, 1924, No. 3, contains two papers on variable stars by Shinzo Shinjo and Toshima Araki. One deals with the correlation between period and light-range in the Cepheids and long-period variables. The light-range is shown to increase with the period, except for a slight retrogression between periods $0{\cdot}8^d$ and 4^d. The group with mean period $0{\cdot}17^d$ have a mean range of 0·70 magnitude, while the range for the group with a mean period of 500 days is more than 5 magnitudes. Moreover, on plotting the ranges and periods as ordinates and abscissæ, a definite bounding curve can be drawn (parallel to the mean curve) which includes *all* the plotted points, indicating a very intimate connexion between period and range.

The other paper is written in support of the theory that both long-period and Cepheid variability is due to revolution in an eccentric orbit of a huge meteoric swarm about a star. The systems X Ophiuchi, Mira Ceti, and 13 Ceti are examined from this point of view, and the periodic terms in the light equations of the variables are considered to be due to perturbations from third bodies (which are sometimes visible, sometimes not). The necessary eccentricity of orbit is examined; for most of the stars it lies between 0·75 and 0·92. No mention is made of the fact on the other side that the interferometer measures of Betelgeuse did not show duplicity, but appeared to indicate a variation of diameter.

Research Items.

PYGMY FLINTS FROM THE PENNINES.—A detailed account of the pygmy flint industry and sites in the Huddersfield area forms part of "Early Man in the District of Huddersfield," by Mr. James E. Patch, which is published as one of the Tolson Memorial Museum (Huddersfield) Publications. The close study of this industry which has been made by Mr. Francis Buckley shows that there is a class of pygmy flints, consisting of small and narrow-pointed tools and small narrow knives, which belong almost peculiarly to the Pennines. The best come from March Hill, where they are associated with the angle gravers and other early types of graver. A second point which emerges is that a large class of pygmy tools made from comparatively broad blades and generally not finely pointed or worked on the side is closely related to Belgian groups. It is thought that the Pennine class is developed from Upper Aurignacian, but where and how, it is not possible to say; while there is probably no Capsian influence in their source as there occur locally both pressure-flaked pygmy tools (Solutré influence) and the busked gravers (Aurignacian influence), neither of which is present in the African pygmy series. It is possible that the latter class came direct from Belgium. It is more Tardenois in type than the earlier and is not developed from it. The character and distribution of the types and sites suggests that Huddersfield and district provided temporary camping grounds for tribes and parties of men migrating to the north and west.

INDIAN CRANIA FROM SOUTH AMERICA.—In view of the scarcity of certain types of South American crania, some importance attaches to measurements published by Dr. H. ten Kate in vol. xvi. N. Sér. of the *Journal de la Société des Américanistes de Paris*. They comprise six skulls, one Carib, two Akawoi, one Arawak, and three Goajiros, also one living subject, a Lengua girl. A comparison is made with other material when available. The greatest head length is 182 mm. (Arawak); the greatest head breadth is 148 (Carib and Goajiros). The indices give the following results:—Sub-brachycephalic, Goajiros (two); hyperbrachycephalic, Carib, Akawoi (one), and Goajiros (one); mesaticephalic, Akawoi (one); sub-dolicocephalic, Arawak. One Akawoi and the three Goajiros were leptoprosopic, and the Carib and Arawak euryprosopic. One Akawoi and one Goajiro were platyrhine, the Arawak and a second Goajiro mesorhine, and the Carib, the third Goajiro, and second Akawoi leptorhine. The orbital index gave one microseme, Arawak, and the remainder megaseme. Prognathism is noted in Arawak, Akawoi, and two Goajiros. The living Lengua subject, a girl of about fifteen years, had a cranial index of 79·3, a nasal index of 86, and showed well-marked prognathism.

ABNORMAL MORPHOLOGY OF THE SHOOT OF OSMUNDA.—In the Manchester Memoirs, Vol. 68, No. 5, 1924, Prof. W. H. Lang describes some curious deviations from the normal in the development of young plants of *Osmunda regalis*, the phenomena being possibly connected with injury or with unusual conditions of cultivation in a greenhouse heated during the winter months. In addition to recording the production of shoot axes from the tip of what appears to be cylindrical green equivalents of a leaf, as well as laterally from such cylindrical rudimentary leaves or from a petiole with a lamina, Prof. Lang records a number of cases in which juvenile leaf forms pass over at their extremity into aposporously produced prothallial expansions, bearing rhizoids.

FUNGI ROTTING APPLES IN STORAGE.—As the result of the systematic examination of apples in storage during 1921–23, for the Food Investigation Board, M. N. Kidd and A. Beaumont publish in the Transactions of the British Mycological Society, vol. x., September 1924, the most complete list yet supplied of the fungi found associated with rotting apples. In examining these fungi to see whether they were responsible for the decay with which they were associated, inoculations from single spore cultures have been carried out in most cases, the method used being a new one. "Small pieces of glass tubing about 2 mm. long, previously plugged with cotton-wool, were fastened by means of luting wax to the surface of the apple, and then were partially filled with sterile liquid media and spores of the fungus sown in the liquid. By this method germination takes place under favourable conditions, and every facility is given the fungus to invade the healthy tissue."

WATER-CONTENT OF YEAST CELLS.—The November issue of the Journal of the Institute of Brewing contains a paper by N. C. Beetlestone, dealing with the actual proportion of moisture in the yeast cell. The moisture content of pressed yeast is composed of the "inherent" moisture of the cells themselves, together with the "adherent" moisture occupying the inter-cellular spaces. The total moisture is determinable readily and accurately. The yeast is mixed with water and filtered, and the specific gravity of the filtrate is measured; then a known weight of the residual yeast is treated with a definite volume of maltodextrin solution of a certain specific gravity, and by measuring the specific gravity of the liquid after filtration, it is possible to calculate the percentage of inherent moisture of the cells. The result obtained in this way varies somewhat with the age of the yeast, the extreme figures being 52·7 and 45·8 per cent., and the mean 50·8 per cent. The method is subject to various errors, but the above figures show that, under normal conditions, the yeast cell contains approximately one-half of its weight of water.

NEW SPECIES OF CHILINA.—The South American freshwater genus of molluscs, Chilina, sole representative of its family, is not so well known but that the record of additional species is noteworthy. Mr. W. B. Marshall has now been able (Proc. U.S. Nat. Mus., vol. lxvi.) to add six new species and a new subspecies to the known list. Three of these came from obscure lakes and rivers in the Andes, along the border between Chile and the Argentine; one from an undefined locality in southern Chile; Lake Nahuel Huapi, province of Rio Negros, Argentina, furnished another; whilst one was obtained many years ago, with fourteen other species of molluscs, from the stomach of a bird on Lake Wafrel, Chile.

THE GEOTHERMIC GRADIENT.—The evidence of the Polish petroleum wells on the geothermic gradient has been recently carefully tested by Dr. H. Arctowski, and discussed in his "Nouvelles Recherches sur les gradients thermiques dans les puits à pétrole de Boryslaw, Krosno et Bitków" (*Bull. Soc. polon. Natur., Kosmos*, 1924, 45 pp.). He finds that the temperature gradient varies in the wells tested from 32·3 metres per 1° C. to 41·7 metres, with a mean of 39·7 metres. This gradient is less than the mean of the European observations summarised by Prof. Daly, which he estimated as 31·7 metres per 1° C., but is near the mean of 41·8 metres of the American

wells. Dr. Arctowski remarks that the differences between the gradients of different areas in Europe are greater than between them and the American wells; and he attributes the differences to many local causes, including variations in subterranean temperature, which are due in some cases to igneous intrusions, while others, he suggests, may be the result of former climatic variations.

STRATIGRAPHY OF WESTERN AUSTRALIA.—The Journal and Proceedings of Royal Society of Western Australia, vol. ix. pt. II, 1923, includes the valuable presidential address by Mr. E. de C. Clarke on "The pre-Cambrian System of Western Australia." He classifies these rocks into five divisions, of which the oldest is the Yilgarn Series, which consists mainly of gneisses and schists. Intrusive into this are the rocks of the Kalgoorlie Series, which include mainly basic intrusive rocks. The third, the Mosquito Creek Series, occurs in the north-western part of the State, and is composed of metamorphosed sediments. It was succeeded by great intrusions of granites. The uppermost division, the Nullagine Series, consists of unaltered sediments with many basic igneous rocks. The age of this division is uncertain, and may be as late as Ordovician. The secondary sulphates and cherts of the Nullagine Series are described by Dr. E. S. Simpson, and he attributes the age of the series to somewhere between post-Huronian and pre-Carboniferous; he regards it as probably Keweenawan, the uppermost division of the pre-Cambrian. Mr. T. H. Withers had described a new Cretaceous cirripede, *Calantica ginginensis*, an interesting addition to the fauna of the Gingin Chalk.

THE USSOI LANDSLIP OF 1911.—The Pamir earthquake of February 18, 1911, was the occasion of a landslip of exceptional magnitude. A geological account of this, by J. Préobrajensky, has been published by the Comité Géologique as livraison 14 of the Matériaux pour la géologie générale et appliquée. The paper is in Russian, without an abstract in any other language, but is illustrated by photographs and maps from which, and from figures in the text, we extract the following particulars. The length of the slipped mass, across the valley, was 14,000 English feet; the width, along the valley, 17,500 ft.; and the depth, from the old ground level to the lowest point on the crest of the slip, was 1750 ft. The cubic contents of the slip are worked out as 2,219,509,670 m.^{3} and the weight as 5,992,676,109 tonnes; the ratio of the bulk of the original rock to the slipped mass is 0·816. The height through which the centre of gravity of the mass fell was 2380 ft., and the horizontal distance through which it shifted, 7350 ft. The depth of water in the lake formed by the slip was 1155 ft. on August 19, 1915, and was still rising. The mass of this slip, in round numbers 6 milliards of tons, is less than that derived by Prince Galitzin from Col. Spilko's survey, yet it places the landslip in a class by itself, for none other, of historic times, which has been measured, comes within one-fifth of its magnitude; it was surpassed, in a greater degree, by the prehistoric Flims landslip, which contains about 42 milliards of tons of rock.

ASPHALT IN PAPER MANUFACTURE.—In the September issue of the Bulletin of the Standard Oil Company, California, are given details of the application of asphalt to the manufacture of heavier varieties of paper. This is a new and interesting departure in the arts, and one destined to become of great commercial importance. Briefly, the manufacture of heavy papers, fibre boards, cartons, etc., consists in treating the original fibrous material to remove impurities, macerating the product, and pulping with water; by suitable process and subsequent drying by heat and pressure the fibrous sheets are formed. With many types of heavy paper, cardboard, and the like, the outer layers are often of better quality material than the infilling pulp, but latterly a demand has risen for a high-quality paper which shall also be water and vermin proof; this is desirable where wrappers or cartons are used for exporting fragile or perishable commodities, as in the United States. Instead of employing cheap infilling material, a layer of asphalt is substituted, or even more than one, according to requirements, such layers being intercalated between several layers of pulp film, depending on the ultimate thickness of the paper or card to be made. For this purpose fluid asphalt is mixed with a small percentage of suitable clay, water is added, and agitation set up. The resulting product is then introduced into the normal paper pulp and the whole dried; water is driven off, and the resulting sheet is richer by the inclusion of one or more layers of impermeable asphalt. The process is patented and is now being carried out on a commercial scale in California, where local resources, both of asphalt and clay, are utilised. It is claimed that not only is the paper or fibre board waterproof, but that its strength is increased approximately 20 per cent. compared with non-asphaltic board of similar thickness; also that its durability is greater than that of ordinary heavy paper or cardboard. Technically, this utilisation of asphalt is another interesting example of asphalt-water emulsion brought about by the agency of very fine and partially colloidal matter such as clay, though all types of clay known to geologists would not serve the purpose efficiently.

THE ELECTRIC ARC WITH NON-INCANDESCENT CATHODES.—In the *Zeitschrift für Physik* of October 17, Dr. A. Günther-Schulze criticises the conclusion of H. Stolt, deduced from his experiments with a rotating brass or copper cathode, that an arc without an incandescent cathode spot is possible. Only approximate calculations can be made of the temperature to be expected in a stationary cathode spot, since the conductivity and specific heat of the metal are not accurately known, but the magnitude of the spot has been found to diminish when the thermal conductivity increases, and for iron the area was $1·4 \times 10^{-4}$ cm.^{2} per ampere. Since brass has about the same thermal conductivity, the size of the spot will be about the same for that metal. The cathode fall is estimated as 15 volts, and an approximate calculation gives 2300° C. for the temperature of the spot, the actual temperature being higher owing to the formation of a film of oxide at the surface. It is also shown that when the spot moves over the surface, as in Stolt's experiment, a temperature of 2500° C. is possible. The spot was not seen by Stolt owing to the brightness of the arc, but in the mercury arc the cathode spot can easily be seen, moving swiftly over the surface, owing to the low brightness of the arc. The fact that the surface of the revolving brass cathode lost its polish confirms the author's views, since in a glow discharge a cold cathode is not attacked, even with a cathode fall of 300 volts.

AN ELECTRONIC BATTERY.—In an address delivered to the Birmingham and Midland Institute, Mr. J. B. Kramer has recently described a piece of apparatus which he has named an electronic battery. The upper surface of a plate of carbon is coated with a radioactive substance, and a plate of metal is placed above and parallel to it, with an intervening air gap. When the plates are connected to the terminals of an electrometer a difference of potential is indicated, the

terminal connected to the carbon being negative and that connected to the metal positive. The maximum potential difference was obtained with zinc. It was possible to obtain a similar, though generally smaller, effect when the two plates were of different metals. Mr. Kramer suggests that the effect is not due to α- or β-rays, but to γ-rays, which may cause a distortion or deformation of the atomic systems of the zinc and carbon atoms, thus rendering one positive and the other negative, owing to the comparative tightness of the bonds by which the electrons are coupled to the nuclei of the two elements. He considers it probable that very few, if any, of the expelled α- and β-particles reach the top plate, and that their energy and charges are spent in collisions or in recombinations.

NEW PHOTOGRAPHIC DESENSITISERS.—MM. Pathé-Cinéma (*British Journal of Photography*, p. 699) find that "basic Scarlet N," made by the Cie. Nationale des Matières Colorantes, is an excellent desensitiser and has several advantages. The weak reddish-brown tint which it imparts to the film is much more easily washed out than the intense red given by saffranine. It does not stain the skin or finger nails as saffranine does, and never produces the general chemical fog that pinacryptol is liable to do. They find also that very many dyes have an intense desensitising action when used in exceedingly weak solutions, one part in a million or even weaker, but at the same time produce a very notable degree of fog. But there are certain other dyes which, if added, get rid of the fogging power while leaving the desensitising power unaltered. As examples of these compound non-fogging desensitisers the authors give formulæ for baths containing rhoduline violet purified (Bayer), methylene blue, and rhoduline sky-blue (Bayer), to each of which pure acridine yellow is added as the protective dye. These baths are very dilute and give scarcely any or no colour to the film. Other protective dyes are auramine, benzoflavine, auracine, cachou brown, and acridine orange, and doubtless many others will be found by further investigation.

X-RAY EXAMINATION OF REAL AND CULTIVATED PEARLS.—M. A. Dauvillier, in the *C.R. Acad. Sci.*, Paris, October 27, describes his results, using Laue photographic diagrams obtained with the K-rays of rhodium and of silver and a quartz tube, with several hours' exposure and a reinforcing screen of calcium tungstate. The real pearls, as might be expected from theory, show regular rings, which are sometimes very sharp, and are due to the doublets Kα and the Kβ lines; mother-of-pearl gives more or less regular Laue figures formed of patches, which are more diffuse than those caused by crystals of calcium carbonate. The mother-of-pearl figures show a certain amount of hexagonal symmetry when the rays are perpendicular to the cleavage planes; when the rays are parallel to these planes the patches are much more numerous, and the symmetry is no longer hexagonal. Cultivated pearls show both the rings, which are due to the outer layer of real pearl, and patches due to the mother-of-pearl core. It is of course unnecessary to cut the pearl in order to make this test. The method appears to be suitable for detecting imitations of other kinds.

THE β-RAY SPECTRUM OF THORIUM B + C.—Dr. W. Pohlmeyer describes an investigation, using the ionisation method, in the *Zeitschrift für Physik* of Oct. 10. The dimensions of the chamber K, in which the rays were magnetically deflected, were large enough to minimise the effect of the secondary rays produced on the walls, which were lined with cardboard to reduce further this effect. A wire coated with thorium-B in equilibrium with its products of disintegration, thorium-C + C′ + C″, was placed 1 cm. above, and parallel to, a slit S_1, of dimensions 3×10 mm., in a lead plate forming the top of K; β-rays of a certain velocity were bent in circles through a large stop by the magnetic field, and were thus focussed on a second slit S_2 at the top of K, and passed into the ionisation chamber through a thin air-tight partition. The ionisation chamber was protected from the direct effect of the preparation by lead blocks. The field was varied step by step, and the ionisation measured for each step. Several lines of thorium-B and of thorium-C + C″ were observed in the resulting curve, and the influence of some of the weaker lines was clearly shown. The spectrum was shown to be limited on the high-velocity side, confirming the results of Baeyer, Hahn, and Meitner. The intensity of the two strongest thorium-B lines is large compared with the continuous background. The experiments, and a discussion of the conditions, show that this background is to be ascribed to secondary influences, including the broadening of the numerous lines obtained in the photographic spectrum, owing to the necessarily large width of the slit S_1 and the preparation wire. Its existence does not invalidate the assumption that the primary β-rays leave the nucleus with a definite velocity.

EFFECT OF PRESSURE ON ORGANIC SUBSTANCES.—The dependence on pressure of the adiabatic cooling of some organic substances in the liquid state has been investigated by N. A. Pushin and E. V. Grebenshchikov (J. Chem. Soc., Oct.). The results show that phenol changes to a denser modification under a pressure of 2250 kg./cm.^{2} and at a temperature of 64·4°. Of all the substances investigated (alcohol, urethane, glycerol, castor oil, etc.), the greatest coefficient of adiabatic cooling (dt/dp) was shown by benzene; the coefficient decreases with increasing pressure in all cases. Some *p*-toluidine and phenol mixtures were also investigated; the results point to the formation of *p*-toluidine phenolate.

STERIC HINDRANCE AND COMPLEX RING COMPOUNDS.—It is well known that a chemical action is often profoundly modified by the presence of groups which exert a definite influence in promoting or in hindering its normal course. No entirely satisfactory solution of the problem will be possible until more abundant experimental data are available. A useful contribution to this subject has been made in vol. 18, No. 2, of *Fortschritte der Chemie, Physik und physikalische Chemie*, "Über die Bildung von Chinon-imiden und Phenoxazonen aus o-Amino-phenolen." Nach Versuchen von E. Mürbe, K. Saurwein, G. Deines und J. Schornstein (Berlin: Gebrüder Borntraeger, 1923, 3*s*.), by K. von Auwers, who with the help of four collaborators has studied the oxidation of derivatives of o-aminophenol. Full details are given of the preparation and oxidation or attempted oxidation of these compounds, and after a critical survey of the results the author has drawn the conclusion that steric hindrance is responsible for any deviation from the normal reaction, which is as follows: an orthoaminophenol is first oxidised by hydrogen peroxide or by air in alkaline solution to a bimolecular quinoneimide, which then condenses further to a phenoxazone. The action may, however, be arrested at the first stage or even entirely inhibited by the presence of certain substituents. The influence of halogen atoms and of the following groups, namely, CH_3, NO_2, CN, COOH and COOEt, in different positions, has been carefully studied and the results are classified.

New Chemistry Department, University of Edinburgh.

THE Chemical Laboratories, the foundation stone of which was laid by the King on July 6, 1920, were formally opened by the Prince of Wales on December 3. The University had resolved in 1913 to build a new chemistry department, and detailed plans were drawn up for its construction, but the outbreak of war led to the postponement of the scheme. Early in 1919 the matter became of immediate urgency, as it had by that time become evident that large numbers of ex-service men were about to enter on university courses in pure and applied science, as well as in medicine. The University met the situation by resolving first to appoint a professor of chemistry in relation to medicine, who would be accommodated in the old laboratories, and second, to erect a new chemistry department on a site affording greater facilities for adaptation and extension than the site originally contemplated.

FIG. 1.—The King's Buildings, University of Edinburgh (Chemistry Department).

The University accordingly purchased some farm land on the southern outskirts of the city, about a mile and a half from the Old College. This land, of 115 acres in extent, is intended to provide sites for all the scientific departments of the University, which will, as necessity determines and as money becomes available, move out to the King's Buildings, the new group being so named with His Majesty's permission.

The Chemistry Building (Fig. 1), excavation for which was begun in November 1919, has a frontage of 220 feet and a depth of 320 feet. It was constructed by Mr. A. F. Balfour Paul, architect, on sketch plans submitted by the professor of chemistry, Sir James Walker. The front block is of two storeys; the remainder is of one storey only, with the exception of a small section to the south-east which has a basement for an engineer's house, cloak-rooms, etc. In this basement is a separate entrance for elementary students. The construction is mainly of brick relieved by stonework on the frontage, which faces due north. The whole building is fireproof, floors and roofs being of reinforced hollow tile.

The general lay-out is indicated by Fig. 2. Three parallel corridors running north and south meet at one end the east and west corridor of the front block, and at the other end are free for extension. Between the central and side corridors are the main laboratories and lecture rooms with their subsidiary offices and service rooms. These are all lit on the factory shed principle by a saw-tooth roof, glazed with north slope window-lights. On the outer face of each side corridor is a range of rooms lit by large windows in the walls. These serve as balance-rooms, etc., for the main laboratories, and as research rooms. On the ground floor of the front block are the physico-chemical laboratories, dark-rooms, and special rooms for gas-analysis, etc.; on the upper floor are the library, administrative rooms, staff common-room, research rooms, and laboratories destined for crystallography, X-ray work, and the like.

The main laboratories are four in number, each 45×70 feet internal measurement. They are fitted with benches to accommodate $72 \times 4 = 288$ students in the elementary laboratory, $72 \times 2 = 144$ students in the laboratory of the second year, 48 students in the advanced inorganic laboratory, and 40 students in the advanced organic laboratory. The physico-chemical rooms can provide working places for about 30 students. Thus the department could take more than 260 students working simultaneously, and has a bench capacity for 550 students. In the special research rooms at present equipped, accommodation can be found for 25 post-graduate workers, a number

capable of being doubled when all the rooms are completed.

A section of the department is devoted to technical chemistry, the object being to familiarise students in a general way with technical plant and processes. There are three small general working laboratories, two research rooms, and a workshop, with office, stores, etc. The equipment is for the most part of a mobile type, the main rooms being fitted on the walls with service pipes for water, gas, steam, electric light and power, compressed air and vacuum, to which small-scale plant can be connected. From 15 to 20 students can simultaneously receive instruction in this section.

There are four lecture rooms, two large (seating capacity 160) and two small (seating capacity 100 and 70 respectively). These are lit by cupolas and three of them can be darkened by lowering a false ceiling operated electrically. The four lecture rooms are served by a single preparation room, adjoining which is a commodious lecture museum.

The heating of the department is effected by means of low-pressure steam, and the ventilation is by extraction, the main inlet duct being under the central corridor, and all air being admitted to rooms over steam pipes or radiators. Each main laboratory is served by an independent fan connected with draught-holes on the students' benches, a scavenging fan being also provided at a high level. The draught-cupboards of the department are connected with two special high-power fans. Each pair of lecture rooms has a fan which runs normally at a low speed, but is capable of changing the air of the room completely in a few minutes between lectures. The air is admitted under the lecture bench and extracted through two sets of apertures in the back wall of the lecture room, one set at head level and the other near the roof.

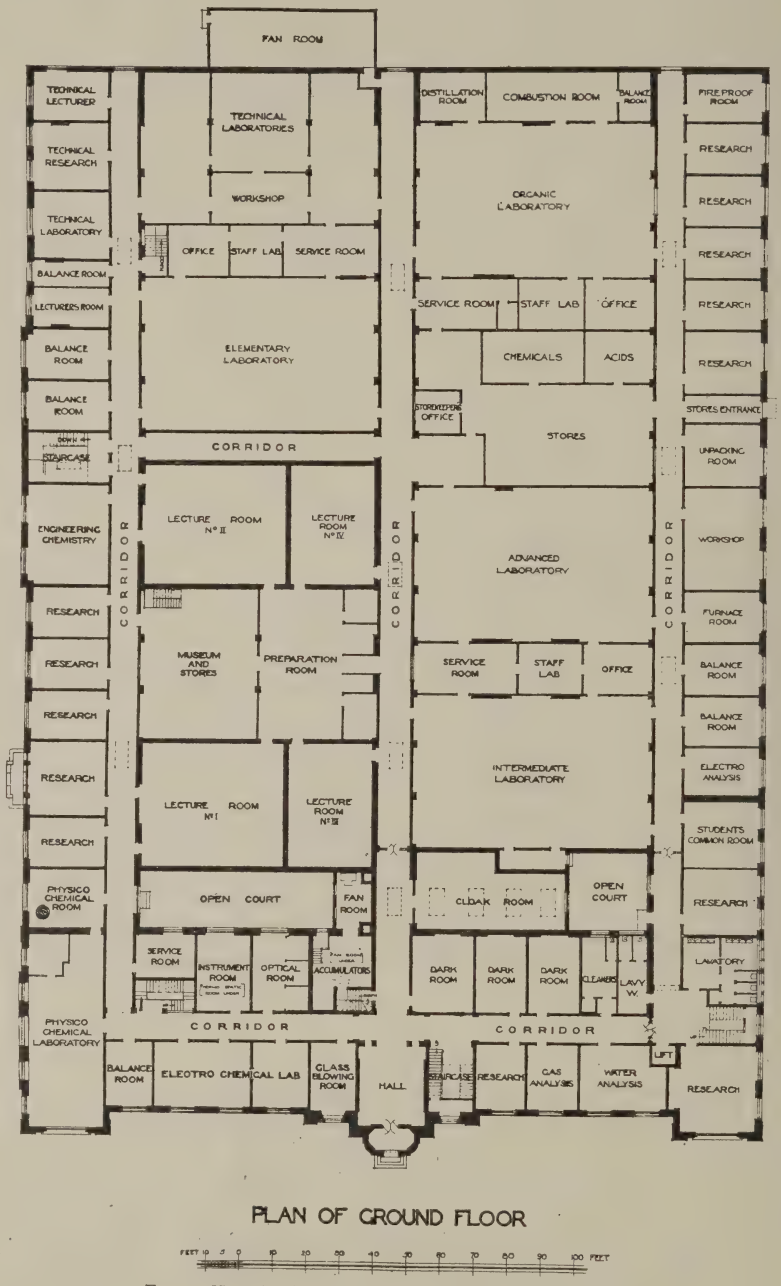

FIG. 2.—New Chemical Laboratories, University of Edinburgh.

Electricity is supplied from the city at 230 volts A.C. and 460 volts D.C. for power. A large motor generator yields direct current at 100 volts for wall plugs, and for charging accumulators, of which there are two sets of 20 cells each—one for electro-analytic and electro-synthetic work, the other for physico-chemical work.

The first section of the department was fully occupied in October 1921, the second in October 1922, and the third and final section in October 1924. The actual cost of the buildings, inclusive of scientific equipment and all other charges, has been somewhat less than 200,000*l*.

At a luncheon following the admission of the Prince to the honorary LL.D. degree, the Principal announced that the deficit of 88,000*l*. on capital incurred since the War had in the preceding few days been met to the extent of 75,000*l*. by subscriptions, including a donation of 50,000*l*. from Sir Alexander Grant.

The Adelaide Meeting of the Australasian Association.

THE seventeenth meeting of the Australasian Association for the Advancement of Science was held in Adelaide, South Australia, on August 25–30 inclusive.

The number of members who attended the meeting is estimated at 750, and delegates from all the important scientific institutions and societies in Australia and New Zealand were present. The delegates who attended exceeded 100 in number, and these represented at least fifty institutions, including the Australian National Research Council, the New Zealand Institute, the various State Royal Societies, the various universities both of the Commonwealth and of New Zealand, the Federal and State Government Departments, the British Medical Association, the various mining, engineering, and chemical institutes, together with kindred institutions.

The retiring president, Sir George Knibbs, inducted the president for 1924–26, Sir John Monash, on the evening of August 25. The president's inaugural address on "Power Development" attracted widespread attention throughout Australia and New Zealand.

Prof. G. Elliot Smith, of University College, London, attended the meeting, and assisted Section F (Anthropology) in urging the Federal Government to found an Australian chair of anthropology at the University of Sydney. The Association also supported a resolution of the Australian Universities' Conference to establish a chair of forestry at the University of Adelaide.

The presidential addresses to Sections included the following: A (Astronomy, Mathematics, and Physics), Prof. D. M. Y. Sommerville, "The Development of the Ideas of Space and Time"; B (Chemistry), Prof. A. C. D. Rivett, "National Research"; B (Subsection Pharmacy), Mr. E. F. Gryst, "Pharmaceutical Progress"; C (Geology and Mineralogy), Dr. H. C. Richards, "Volcanic Activity in Queensland"; D (Zoology), Prof. W. E. Agar, "Some Problems of Evolution and Genetics"; E (Geography and History), Capt. J. K. Davis, "Sailing Directions"; F (Ethnology and Anthropology), Mr. H. D. Skinner, "Origin and Relationships of the Material Culture and Decorative Art of the Maoris of New Zealand"; G (Social and Statistical Science), Prof. D. B. Copland, "Monetary Policy and its Reaction upon Australia"; H (Engineering and Architecture), Prof. H. E. Whitfeld, "Efficiency in Modern Life"; I (Sanitary Science and Hygiene), Dr. J. S. Purdy, "Vitamines and Fruit in Diet"; J (Mental Science and Education), Mr. J. Nangle, "Vocational Guidance"; K (Agriculture and Forestry), Prof. R. D. Watt, "The World's Food Supply"; L (Veterinary Science), Dr. S. Dodd, "Cancer in Domesticated Animals"; M (Botany), Mr. L. Rodway, "Ecologic Conditions of Vegetation in Tasmania."

A general statement was made by the permanent honorary secretary regarding the pressing needs of the Association, inasmuch as it is coming to be seen that science in Australia and New Zealand needs to extend its usefulness, especially in view of the impetus given to the study of Pacific problems by the recent Pan-Pacific Science Congress, and the Food Conservation Congress, held in Australia and Honolulu respectively. This could be accomplished by the Australasian Association acting as co-ordinator of, and spokesman for, the various divergent interests of scientific and technical societies. In other words, the best work could be done apparently by an affiliation of all the scientific institutions with the Australasian Association for the Advancement of Science, and with the hearty co-operation also of the Australian National Research Council and the New Zealand Institute.

The present machinery of the Australasian Association is too cumbrous for this purpose, and it is found necessary to take a central office in Sydney with an officer in permanent attendance to assist the permanent honorary secretary.

A constitution of few articles is needed with flexible by-laws or regulations to each of the main articles. Continuity of membership is needed, and some permanency also for secretaries of Sections, whereby recommendations to Governments and other authorities might be well considered before presentation.

Perth, Western Australia, was selected as the place of the eighteenth meeting of the Association, the date chosen being August 1926. The president for this meeting will be Sir Thomas R. Lyle. The Government of Western Australia has promised 1200*l.*, mainly towards defraying the cost of the publication of the Proceedings.

The nineteenth meeting will be held at Hobart, Tasmania, in January 1928, with the promise of financial support from the Tasmanian Government.

E. C. ANDREWS.

Preservatives in Food.[1]

THE report before us contains an account of the preservatives and colouring matters found in different articles of food, together with the Committee's opinion upon the nature and quantities of these substances which should be permissible, taking into consideration, on one hand, their effect upon the body, and on the other, their efficiency in preserving, or making attractive, the different articles of diet in which they are found. Apart from the main body of the report, a series of appendices gives the names of the witnesses examined, and excerpts from the laws of other countries on the use of preservatives and colouring matters in foods, with details as to those which are permissible and which prohibited: one other appendix will be referred to in more detail below.

The principles which guided the Committee in the interim report on the use of preservatives in meat, which have already been noticed in these columns (NATURE, September 20, p. 448), are emphasised again in the report under consideration. Since the ideal of the consumption of fresh food alone is impracticable of attainment under modern conditions of civilisation, and cold transport or sterilisation by heat may be unsuitable processes in certain cases, the only course open is to use some preservative, and the Committee has devoted considerable attention to the question as to which preservatives are the least likely to be harmful to the individuals consuming them in small quantities, although often over long periods of time, and yet are reasonably efficient in preventing decomposition or other change in the food or drink product. In certain cases, preservatives have a further disadvantage in that their addition may give a sense of false security and encourage slackness in the preparation of the food: in other cases their use seems to have become a habit

[1] Ministry of Health. Final Report of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food. Pp. 84. (London: H.M. Stationery Office, 1924.) 1s. 6*d.* net.

with some of the manufacturers of certain articles of food, such as pickles, since others do not use them at all.

The report considers first the different substances which have been used as preservatives and their effect upon the human economy; they can be divided into three groups. In the first are hydrofluoric acid, its salts and derivatives (seldom if ever used at the present time), and formaldehyde and its derivatives. The effects of the latter have been already mentioned in the account of the Committee's Interim Report and will not be further considered here. It is sufficient to state that in the opinion of the Committee, with which we are in complete agreement, the substances in this group should be completely prohibited in articles of diet. In the second group are placed boron preservatives and salicylic acid and its salts: these should also be prohibited. Although this conclusion may cause some surprise, the evidence in favour of it is remarkably strong. In the first place, both boric and salicylic acids act as irritants to the alimentary tract; the former, moreover, is only excreted slowly after absorption, so that its action is cumulative. Boric acid or its salts are used at present very largely in cream, butter, liquid eggs, margarine, and potted meats, or dusted over bacon and hams exported to Great Britain: but since these products are frequently sold without the addition of preservatives, it appears quite possible to dispense with them, providing methods of preparation and conditions of transport are satisfactory. This conclusion is strengthened by the fact that at the present day the milk supply is satisfactorily maintained although the addition of preservatives is forbidden, a state of affairs which, twenty-five years ago, was considered to be impossible of achievement in some quarters. As regards salicylic acid, which is used chiefly in beverages, benzoic acid has about the same effectiveness as a preservative and is less irritant to the stomach, and is therefore preferable.

The third group comprises the least harmful of the preservatives in benzoic acid, sulphurous acid, and their salts: the report gives a list of the foods and beverages in which they may be permitted, together with the maximum amounts allowable. Sulphur dioxide may be permitted in sausages, jam, dried and preserved fruits, beer and cider, and wines, cordials, and fruit juices, in amounts of a few grains per pound or pint. Benzoic acid should be allowed only in the following beverages: coffee extract, non-alcoholic wines and cordials, and sweetened mineral waters and ginger-beer.

Turning to the question of colouring matters, the Committee advises the prohibition of the use of copper sulphate as an agent for preserving the colour of green vegetables. They consider that this will not affect the sale of canned vegetables, seeing that peas canned without the use of copper find a ready sale in Great Britain. As regards other colouring matters, a few pigments containing iron and some natural organic colours such as gamboge, saffron, caramel, and cochineal are considered harmless: but of the synthetic aniline dyes, relatively few have been considered harmless in other countries, and the Committee recommends that a list of those permitted should be drawn up by the Minister of Health: this is necessary, since many of these dyes are potent antiseptics in dilute solutions; moreover, they cannot be grouped in classes, since a harmful product may be closely related to one that is quite innocuous.

Finally, the report considers the best method of making its conclusions effective: among its recommendations here is one that the amount of preservative or nature of colouring matter permitted should be definitely laid down by law, and another that the processes of preparation of food for human consumption should be under closer control. In this connexion, improved methods and facilities of transport and storage are urgently required. In one of the appendices is given an interesting example of the co-operation of a trade in reducing the amount of preservative present in a food, by its members agreeing not to use the article containing it in certain types of foodstuffs prepared by them. The report should do much to raise the standard of preparation of food in Great Britain.

Works of Early Man in East Anglia.

AT the autumn meeting of the Prehistoric Society of East Anglia, held at the rooms of the Geological Society, Burlington House, London, on November 12, Mr. R. A. Smith, and afterwards the president, Mr. Henry Balfour, in the chair, special reference was made to the loss sustained through the death of the late Mr. E. T. Lingwood, of Westleton, who, in addition to great abilities and enthusiasm as a practical excavator and collector of flint implements, had for years done very valuable voluntary work by drawing large numbers of the specimens selected for illustration in the annual Proceedings of the Society. Had Mr. Lingwood lived, a proposal to offer him honorary membership of the Society would have been brought forward at the next annual meeting, and it was unanimously resolved by the London meeting that this distinction should be offered to Mrs. Lingwood, together with an expression of the sympathy of the members of the Society.

An important announcement concerning the protection of Grime's Graves, Norfolk, as a national monument was made by the hon. secretary, Mr. G. Maynard, of the Ipswich Museum, who stated that H.M. Office of Works has accepted a suggestion made on behalf of the Society and has taken steps to include in the schedule a considerable area of the open warren which borders the well-known group of ancient flint mines on the Weeting Hall estate. The additional area includes the sites of the recently discovered pits on the slopes of the Grime's Graves ridge which are being investigated by Mr. A. L. Armstrong.

It was also announced that with the approval of the Office of Works, the owner of the estate has given permission for the erection of a shelter over the mouth of the pit cleared out by the Society in 1914 and subsequent years. This protection is designed to prevent the silting up of the entrance to the galleries at the bottom of the pit, and to facilitate entrance to the old mine workings. The delimitation of a footpath across the warren to the site has also been agreed to. Information as to the probable cost of the shelter is being obtained, and the council of the Society is shortly to be asked to consider the question of taking up the scheme.

Mr. J. P. T. Burchell described some stratified finds on the North Kent coast, where the peculiar elongated flint implement known from its abundance in the bed of the Thames as the "Thames pick," is found in plenty at the foot of the cliffs but is without a definite geological horizon. The cliffs examined are at Bishopstone near Reculver, and Hampton near Herne Bay. At the former site, hand-axes of Chelles and St. Acheul type have been found in the ochreous gravel which is capped by brick earth, with Neolithic flakes and cores in its upper levels.

Sunk in the top of the brick earth and adjoining

a shell-heap with Early Iron Age pottery, a hearth has been found containing flint flakes and a small circular implement. An interesting discovery is that an undisturbed stratum of gravel, 5 inches deep, seals in the Iron Age hearth and midden; and above this is 1½ feet to 4 feet of loam with flints and more pottery and burnt flints to the surface. As the Thames pick can scarcely belong to the Iron Age and is probably later than the drift, the only course is to refer it to the lower part of the brick earth.

Mr. W. H. Cook reported on the discovery of a flint implement working-site of late St. Acheul or early Le Moustier date in the Medway valley. Several thousands of flint artifacts were found lying in heaps covered by brick earth and apparently undisturbed since the mid-Pleistocene period. Excavations in the chalk near Frindsbury opposite Rochester have revealed a chalk slope more than half a mile in length leading down to the alluvial plain of the Medway. On the chalk slope are a series of gravels and brick earths resting at various levels on well-defined platforms or terraces. At 90 feet above the river level and corresponding to the 100-foot terrace of the Thames and Somme are the beds of the ancient Medway, which are of the same Chellean-Le Moustier age. The recent discovery was made in a shallow deposit of dark clayey brick earth probably representing the alluvia of the ancient 100-foot terrace river, as it occurs on the upper limits of the terrace and lies in a hollow of an ancient calcareous surface loam which is clearly older than the terrace deposits. In addition to palæolithic hand-axes, scrapers and grattoir, hammerstones, masses of flint flakes and numbers of massive core pieces were found. None of the cores were, however, of the tortoise-backed type. An accumulation of coarse sub-angular fragments of chalk, apparently equivalent to the well-known Coombe rock of Northfleet, etc., was found at the junction of the chalk with the drift beds at various levels, but it is clearly of later age than the 100-foot terrace.

Dr. Cyril Fox, of Cambridge, dealt with evidence of continuity of occupation of a site known as Bellhus, at Abington Pigotts, Cambridge, from Early Iron Age down to late Medieval times. The settlement had probably been founded in La Tene I. times (400–250 B.C.), possibly as a result of the general tendency elsewhere exemplified during this Age for migration to take place from the pasture-land to the more fertile districts bordering the alluvium, and thus connected with the early development of corn growing. The evolution of the pottery forms during the Early Iron Age was discussed and many examples shown. The abundance of 1st century A.D. finds seems to show that no serious setback in prosperity accompanied the Roman conquest and the story of the settlement only became obscure after A.D. 390. Certain pottery forms, particularly the Roman mortarium, seem to show an evolution into types which can be clearly distinguished as Early Saxon.

Mr. A. L. Armstrong reported upon the past season's work at Grime's Graves, Norfolk. The continuance of last year's excavations has shown that the simple shaft-pits discovered on the outer slopes of the site are placed close together in rows. The extremely compact nature of the filling and absence of surface indications were again noted, as well as the absence of galleries and deer horn picks. The work appears to have been done with short hand-picks of bone. Excavation of a large hearth in one of the old shaft hollows on the higher ground has yielded several examples of pottery now dated as Hallstatt, Early Iron Age.

University and Educational Intelligence.

EDINBURGH.—The Prince of Wales visited the University on December 3, for the purpose of opening the new Department of Chemistry, King's Buildings, which has recently been completed at a cost of about 200,000*l*. Immediately afterwards, at a special graduation ceremony in the M'Ewan Hall, the Chancellor of the University, Earl Balfour, conferred on His Royal Highness the honorary degree of LL.D. At the subsequent luncheon, the Principal announced that Sir Alexander Grant had given 50,000*l*., that the Carnegie Trust was likely to add 15,000*l*., and gifts from other sources amounted to 10,000*l*., which, he stated, would bring relief, encouragement, and hope to those who administer the affairs of the University, though the University's need remained yet so great that he trusted there was a larger harvest to follow.

To commemorate the hundredth anniversary of the foundation of the Royal (Dick) Veterinary College, a Centenary Post-graduate Fellowship has been instituted. A Fellowship Fund has been established, and a deed has recently been signed by which trustees have been appointed to administer the Fund. The aim of the Fellowship is the assistance of promising graduates who may wish to pursue further study and research, and it is hoped that in this way the advancement of veterinary science may be promoted. The amount of the Fund is at present 5802*l*., but the trustees feel confident that additional contributions may be expected from those who benefit from the discoveries of veterinary science, as applied to animal husbandry and public health.

LEEDS.—Applications are invited for two posts, namely, an assistant lectureship in agricultural botany and a demonstratorship in the same subject. Particulars may be obtained from the registrar, to whom applications for the posts should be sent by, at latest, December 22.

LONDON.—The following doctorates have been conferred:—*Ph.D.* (*Science*): Miss M. A. C. Boas (Lister Institute of Preventive Medicine) for a thesis entitled "Part I. A Method for estimating Calcium and Phosphorus Retention in young growing Rats; Part II. The effect of Green Food in the Diet on the Calcium and Phosphorus Metabolism of Rats as compared with that of Cod Liver Oil"; Amar Nath Puri (Rothamsted Experimental Station) for a thesis entitled "Soil Colloids—A Study of Phenomena relating to Surface Forces in Soil"; Mr. H. Gregory (Imperial College—Royal College of Science) for a thesis entitled "Experimental Determination of the Thermal Conductivities of Gases," and other papers; Mr. E. Spencer (Imperial College—Royal College of Science and University of Liverpool) for a thesis entitled "Investigations of Problems connected with the formation of Authigenous Minerals in Clays, Coals, and Limestones from India and elsewhere"; Mr. Murray Stuart, for a thesis entitled "The Potash and Rock Salt Deposits of the Punjab and Kohat"; Mr. G. F. J. Temple (Birkbeck College) for a thesis entitled "Researches in Whitehead's Theory of Relativity," and another paper; Mr. H. G. Turley (Battersea Polytechnic) for a thesis entitled "Experiments on the Walden Inversion. The α-Hydroxy Acids and their Derivatives with special reference to Lactic Acid." *Ph.D.* (*Engineering*): Mr. G. F. Dutton (Imperial College—City and Guilds College) for a thesis entitled "Some Acoustic Properties of Telephones."

Applications are invited for the Keddey Fletcher-Warr studentships for the promotion of post-

graduate research. The studentships are tenable normally for three years, and are of the annual value of not less than 200*l*. They are open to men and women of European descent who are graduates of a British university or of similar standing, preference being given to a graduate of the University of London. Further particulars are obtainable from the Academic Registrar, University of London, South Kensington, S.W.7. The latest date for the receipt of applications is January 31.

THE Faraday House Electrical Engineering College, Southampton Row, W.C.1, has an opening for an assistant lecturer in mathematics and physics or chemistry. Preference will be given to an engineering graduate. Written applications should be sent to Dr. A. Russell, at the College.

THE University College of the South-west of England, Exeter, has sent us a copy of the annual reports of its Council and Senate for 1923–24. The Council has co-operated with the Plymouth Education Authority in planning an extension of the work of the College to Plymouth. A scheme has been framed for the institution of degree and diploma courses in engineering (civil, electrical, marine, and mechanical) and in commerce, to be conducted in Plymouth, and for the extension of the law teaching and extra-mural work now carried on there by the College. Pending the maturing of the scheme and the provision of the requisite funds, the College Council will be represented on a sub-committee constituted for the purpose of advising the Plymouth Education Committee on the administration of the Plymouth Technical Schools, and the Principal of the College will give part of his time to acting as supervisor in these schools.

THE New York correspondent of the *Times* records that Mr. George Eastman, founder of the Eastman Kodak Company, who has already given away half his holdings of stock in that concern, has made gifts of the remaining half to several institutions of learning. At the lowest estimate this half is worth about 3,000,000*l*. Of this amount, about 1,700,000*l*. will go to the University of Rochester, and about 900,000*l*. to the Massachusetts Institute of Technology. This will bring the total of Mr. Eastman's gifts to the latter institution up to 3,000,000*l*. The remaining money, about 400,000*l*., will go to the Tuskegee Institute, the Hampton Institute, and the Southern Schools for the Education of Negroes, but these gifts are contingent on gifts of a like total from others.

THE annual statement for 1923–1924, of the Rhodes Scholarships, has recently been issued by the Rhodes Trust, Seymour House, Waterloo Place, London, S.W.1. The number of scholars in residence during the year was 220, of whom 109 were from the British Empire and 111 from the United States. Grouping the scholars according to their studies, it appears that mathematics claimed 60 and natural science and medicine 57, while education, forestry and agriculture, and anthropology claimed 4, 2 and 1 respectively. The present academic year opened with 180 scholars in residence. Information about Rhodes Scholarships may be obtained on application to the offices of the Trust. In the United States application may be made to President Aydelotte, Swarthmore College, Swarthmore, Pennsylvania; in Canada to Mr. J. M. Macdonnell, National Trust Company, Ltd., Montreal, P.Q.; in Australia to Mr. J. C. V. Behan, Trinity College, Parkville, Victoria; in South Africa to Mr. P. T. Lewis, South African Chambers, St. George's Street, Cape Town.

Early Science at the Royal Society.

December 14, 1664. The experiment mentioned by Monsieur Huygens of making a thermometer with a cane of salt-water and a glass-ball poised in it, was tried; and it was found that the glass-ball rose and subsided, according to the alterations of heat and cold. It was ordered, that it be kept and compared with the other thermometers, in order to see whether it be so nice and sensible as they.—There was read a paper sent from Oxford by Mr. Boyle to the secretary, containing certain proposals of Mr. Austen, about the planting of fruit and timber-trees which Mr. Austen desired might be recommended to the parliament. It was referred to the committee for agriculture.

December 16, 1663. Mr. Waterhouse gave notice of a letter received by him from Mr. Children, signifying, that the thermometer sent to him was broken: as also, that he would shortly communicate his manuscripts of observations of the weather, and first of all those of three several persons made upon every day of the year 1648.—Mr. Hooke proposed an experiment to be made with the compressing engine, of applying a gun to it, to see with what force it will be able to shoot a bullet, arrow, etc. The operator was ordered to prepare a gun for this purpose.

December 17, 1668. At this meeting were present two Italian gentlemen, the Marquis Ricardi, and Signor Seoni, both introduced by Count Umbaldino. They acquainted the society of the singular respect, which the Cardinal Leopold de Medicis had for them, and that he desired to have his excuse made for not having himself returned his acknowledgments for the "History of the Society" [Sprat's] sent to him, which he had been hindered from doing by his lately received dignity of Cardinal; but that since that time he had desired and already obtained the Pope's permission to correspond with the society, of which he now intended to make use, to let them see the esteem, which he had of them and their institution.—The president thanked these gentlemen for acquainting the society with so favourable an inclination of his Eminence to them, and that they would study to entertain so noble and promising a correspondence with all reciprocal services.

December 18, 1679. Mr. Henshaw read a paper, which he had from Dr. Plot, copied from the Records in the Tower, containing an account of the strange recovery of certain persons a long time after their having been executed.

December 19, 1666. It was ordered that at the next meeting the experiment be made of transfusing the blood of a sound dog into a mangy one; and that the operator provide necessaries for it, to begin the operation about twelve o'clock that day. Mr. Boyle suggested that it might be considered to make an estimate of what proportion of blood is let out. Dr. Pope moved, that a trial might be made of letting out half the blood of a dog, and of supplying it with warm milk, or, because milk may coagulate, with a liquid of barley-cream. Mr. Boyle mentioned, that not only care must be had of the kind of liquor to be injected, but also of the manner and place of the injection; in default whereof the liquor would drive the blood before it to the heart and by too great abundance crowding in there kill the animal. To avoid which, it might be injected by degrees, and in the remoter parts from the heart, as in a crural vein.

1667. Mr. Coga being introduced gave an account of the effects of the experiment of transfusion repeated upon him, viz., that he found himself very well at present, though he had been at first somewhat feverish upon it; which was imputed to his excess in drinking too much wine soon after the operation.

Societies and Academies.

LONDON.

Royal Society, December 4.—A. **Fowler**: The structure of the spectrum of ionised nitrogen. New observations of the second line spectrum of nitrogen (N II or N^+) have been made in the region λ6650 to λ2200, and 52 lines have been classified. In this region, all the terms which have been identified belong to singlet or triplet systems. These have been found to combine with each other in agreement with the selection rules which are applicable to other spectra in which p' and d' terms appear. The absolute values of the terms cannot yet be stated, but a value of 70,000 has been provisionally assigned to $2p$, in accordance with the value suggested for $1p$ by astrophysical data. The largest term identified is a p term, and it may be inferred that the series electron in singly ionised nitrogen normally occupies a 2_2 orbit, so that the atom of N II has two electrons in 1_1 orbits, two in 2_1 and two in 2_2 orbits. It is also the probable arrangement of orbits in the neutral atom of carbon, the spectrum of which has not yet been resolved into series. Three groups of lines which involve one of the p terms are remarkable as showing large displacements (> 0·5 A) to the red in vacuum tubes containing nitrogen at relatively high pressures.—H. **Jeffreys**: On the formation of water waves by wind. The wind presses more strongly on the slopes of the waves facing it than on the sheltered slopes, and when the resulting tendency of the waves to grow is just able to overcome viscosity, waves are first formed. A numerical constant in the theory can be adjusted to make the wind velocity required to produce waves agree with observation; and when this is done the predicted wave-length of the waves first formed agrees with observation without further assumption. To account for the skin friction of the wind over the seas as the resultant drag due to the horizontal thrust of the wind on the exposed sides of the waves, wave velocity must be about three-quarters of the wind velocity, which is in accordance with observation. The formation of waves with such a velocity, however, appears to require values of the eddy-viscosity much smaller than are indicated by observations of ocean currents.—J. E. **Jones**: (1) On the determination of molecular fields. III. From crystal measurements and kinetic theory data. With the information obtained about argon in earlier papers from its properties as a gas, theoretical calculations are made of the interatomic distances to be expected in argon as a crystal. Crystalline argon has recently been obtained, and its structure measured and examined, and it is thus possible to fix the molecular field of argon. Theoretical calculations are also made of interatomic distances in potassium chloride and calcium sulphide which are in good agreement with observations. (2) On the atomic fields of helium and neon. The atomic field of helium is determined from measurements on its isotherms and viscosity, that of neon from measurements of its viscosity, and heat conduction and the crystal constants of sodium fluoride and magnesium oxide.—F. S. **Tritton**: A centrifugal method of making small pots of electrically fused refractory materials. A method is described of making small pots of refractory materials (magnesia, alumina, zirconia, and tungsten metal) by electric arc fusion combined with centrifugal action. The material, shrunk by previous fusion and finely powdered, is placed in a silica cup and a deep central depression is made in the powder. Two graphite electrodes fit closely into this depression. In the case of alumina or zirconia, in order to prevent the formation of carbides, a stream of oxygen is blown between the electrodes and the refractories during fusion. Pots of fused magnesia made in this way have been successfully used for holding molten iron oxide, which penetrates all other known refractories.—J. W. **Nicholson**: Spheroidal wave functions. The paper develops a new class of solutions of the equation of wave motion, in oblate spheroidal co-ordinates, satisfying boundary conditions which can be made identical with corresponding conditions in problems of solutions of Laplace's equation. The new solutions are not of the form of products of functions of single "normal" co-ordinates appropriate to the spheroid, but they nevertheless can be applied readily to the exact solution, without the use of harmonic series, of problems of diffraction of waves by circular discs.—J. V. **Howard** and S. L. **Smith**: Recent developments in tensile testing. When a steel test piece is pulled beyond a limiting stress, the removal and re-application of the load causes a loop to be traced in the load-extension diagram recorded by the Dalby autographic load-extension recorder. The extension which occurs when a loop is being traced is analysed into a proportionally elastic portion and a non-proportionally elastic portion (recoverable slip) which depends only on stress. Permanent set is the ultimate cause of rupture, and is caused by the act of looping. The stress required to produce a standard mean loop-width provides a means of comparing different steels as regards that property of the metal which is revealed by this method of testing. Under certain conditions of heat treatment and composition, no recovery takes place at ordinary temperatures; nor does steel recover if left in a state of stress.—F. C. **Harris**: The photo-elastic constants of glass as affected by high temperatures and by lapse of time. The stress-optical coefficients of several glasses, of known chemical composition, at different temperatures up to 400° C., with only one exception, show a general increase with rise of temperature. The exception was an extra dense flint, containing a high percentage of lead. The stress-optical coefficients increase comparatively rapidly during the first year or two after being cast, and finally settle down to a steady value.—A. L. **Narayan** and D. **Gunnaiya**: Absorption and dispersion of thallium vapour. The non-luminous vapour of thallium absorbs lines of sharp and diffuse series. At about 900° C. a number of bands of diffuse and complex structure, and some lines, made their appearance, probably due to Tl_2 molecules. The vapour does not exhibit any selective absorption in the region 0·9μ to 1·35μ, and that therefore $1,\pi_2 - 1,\pi$, is not the single-line spectrum of the metal. The work confirms the findings of H. Geisler and Prof. McLennan, that at λ5350·6 the vapour exhibits anomalous dispersion, though feebly. Further, the experiments indicate more prominently the existence of anomalous dispersion at λ3775·7.—R. d'E. **Atkinson**: Note on Vegard's theory of the aurora. The presence of solid nitrogen would not account for auroræ at great heights since (1) there probably cannot be a strong enough field to lift crystals; (2) the volume charge they would carry would be impossibly large if enough light were to be obtained; (3) the largest crystals that could be lifted would probably be completely vaporised by one electronic impact; (4) solid nitrogen probably cannot emit a narrow line. The possibility of low enough temperatures is disproved. The experimental evidence of Vegard is inconclusive. Two alternatives, in which the aurora is explained as a purely gaseous luminescence, are outlined, and the possibility that the gas might be oxygen instead of nitrogen (so far as 5578 is concerned) is discussed.—M. **Weinberg**: The spark spectra of indium and gallium in the extreme

ultra-violet region. The spark spectra were examined in both quartz and vacuum-grating regions. Since they oxidise very easily in air, their spectra in the quartz region were taken in hydrogen. There are altogether 107 indium lines in the quartz region, some of which are extremely faint. They extend over a range of 1855 to 2337 A.U. There are fewer gallium lines in this region. These range over 1855 to 2364 A.U. Both elements in the vacuum grating spectrograph show a great mass of lines in the extreme ultra-violet. On elimination of the impurities, however, it was found that there were 828 gallium lines ranging over region 157-2059 A.U., and 464 indium lines ranging over 161-2082. In gallium there were a few very faint lines extending so far down into ultra-violet as $\lambda = 126{\cdot}8$ A.U.—S. W. **Richardson**: The general law of electrical conduction in dielectrics.—T. **Lewis**: The interpretation of the results of Bucherer's experiments on e/m. The whole of the traces obtained by Bucherer in his e/m experiments may be used in order to verify the mass formula for the electron. The experimental traces confirm the validity of the Lorentz formula for high velocities provided electrons with these high velocities are emitted in sufficient number to produce the desired photographic effect. Electrons must be emitted with velocities up to at least 0·94 of the velocity of light. This is higher than the velocities recorded by Ellis up-to-date, but well within the range observed by Danysz.—A. M. **Mosharrafa**: On the quantum dynamics of degenerate systems. A set of quantum restrictions is suggested for degenerate conditionally periodic systems, in the form $Y_j = \tau_j h$, where Y_j is a specified "adiabatic invariant." The conditions are applied to the case of the hydrogen atom in the presence of an external electric field and lead to the adoption of "half-integral orbits" in the Stark effect. The origin of fractional quantum numbers is to be sought in the mechanism of degenerate systems.—E. G. **Dymond**: On the precise measurement of the critical potentials of gases. Automatic differentiation of the characteristic curves increases the sharpness of the bends in them. The reasons for the divergence of the value found for the first excitation potential of helium, 20·9 volts, from that calculated from the optical data, are discussed.—I. **Langmuir** and K. H. **Kingdon**: Thermionic effects caused by vapours of alkali metals. At high filament temperatures, positive ion emission becomes limited by the rate at which vapour comes into contact with the filament, all atoms striking the filament being converted into ions. This permits quantitative measurements of vapour pressure to be made. At lower filament temperature, electric image force causes a fraction θ of filament surface to be covered by a layer of adsorbed ions, which share electrons with the underlying metal. The resulting double layer causes increase in electron emission and corresponding decrease in positive ion emission. Electron emissions of more than 0·3 amp. per cm.^{2} at 1000° K. may be obtained in cæsium vapour 30° C. The theory of dilute adsorbed films ($\theta < 0{\cdot}2$) is developed. Equation of state for adsorbed film is found to correspond to ideal gas laws. For more concentrated films, attractive forces draw the ions together, and under certain conditions separate 2-dimensional phases appear. Heat of evaporation of adsorbed cæsium atoms on tungsten in the form of ions corresponds to 4·0 volts for dilute and 4·3 for concentrated films. From adsorbed oxygen on tungsten, heat of evaporation of cæsium ions is 5·1 volts.—C. Tate **Regan**: Dwarfed males parasitic on the females in oceanic angler-fishes (*Pediculati Ceratioidea*). Dwarfed males parasitic on the females are described in Ceratias (female, 1000 mm., male, 105 mm.) and Photocorynus (female, 65 mm., male, 10 mm.). Outgrowths from snout and chin of the male unite in front of the mouth and fuse with a papilla of the female. The skin of the two fishes is continuous, and beneath it the outgrowths of the male and the papilla of the female consist of highly vascular fibrous tissue: the blood systems of the two are continuous, a unique type of parasitism. In the male, teeth are absent and the gut is vestigial. Other ceratioids examined are all immature females: no free-swimming males are known in the group. The ceratioids are bathypelagic, piscivorous, solitary, and sluggish: they float about in the darkness of the middle depths of the ocean. It is suggested that the difficulty experienced by mature fish in finding a mate led the immature males to attach themselves to the females at the first opportunity, with the result that in the end the males became dwarfed and parasitic.

Royal Microscopical Society (Industrial Applications Section), October 22.—R. H. **Greaves**: Supersaturated solid solutions. In many alloy systems, the limit of saturation of the α solution decreases with fall of temperature. This is so with a group of ternary alloys of copper and aluminium with nickel, also with manganese and with other elements. These α solid solutions can be obtained in the supersaturated condition at atmospheric temperature by quenching. Subsequent heat treatment hardens the alloy by precipitating the excess of the dissolved constituent. To obtain maximum hardness, the whole of the excess must be precipitated in extremely fine particles (critical dispersion). These are far below the limit of visibility under the microscope ($0{\cdot}25\mu$ or 1000 atoms diameter). This does not seem possible with the alloys mentioned, since a treatment which ensures complete precipitation at the same time induces coalescence. It is possible, however, in aluminium alloys and is illustrated by the ageing of duralumin, and some other alloys containing magnesium, at atmospheric temperature. Increased resolving power would enable the study of the precipitated particles into the region of the critical dispersion, but it has been possible to interpret the structure by inference from other tests, and the practical problem of correct heat treatment has therefore not been delayed.

Faraday Society, November 17.—A. P. **Laurie**: Note on the expansion of water while freezing. Assuming that the atomic diameters based on Bragg's crystal model for ice are true for liquid water, and that liquid water at 0° is a trihydrol, it follows as a geometrical necessity that there will be an expansion from 1 to 1·088 when ice melts. This gives a sp. gr. for ice of 0·918; and the experimental value is 0·917, thus confirming the original assumptions.—R. W. E. B. **Harman** and F. P. **Worley**: The hydrolysis of alkali cyanides in aqueous solution. The vapour pressure of hydrogen cyanide over solutions of potassium cyanide was compared with that over solutions of hydrocyanic acid, and it is shown that the degree of hydrolysis of sodium cyanide at 25° at all concentrations is the same as that of potassium cyanide. The effect of temperature was also studied. The constancy of the hydrolytic constants at different concentrations at each temperature, the agreement of the values at different temperatures with the Van 't Hoff isochore, and the agreement between the calculated heat of hydrolysis and the measured heat of neutralisation appear to confirm the accuracy of the values arrived at for degree of hydrolysis at the various concentrations and temperatures employed.—S. S. **Joshi**: Viscosity of reversible emulsions.

Viscosities of water-in-oil emulsions prepared from castor oil, olive oil, and paraffin oil by means of four monovalent soaps are determined. Viscosity increases with increase of the dispersed phase and is a maximum at the reversal point, which is followed by a sudden drop in viscosity upon inversion. The concentration and the specific chemical nature of the emulsifying agent have no effect on the viscosity of the emulsion. Hatschek's equation for the viscosity of the emulsoids is not followed; observed viscosities are in approximate agreement with those estimated by Einstein's equation for suspensoids; Arrhenius' equation applies better still. The size of the grains of the water-in-oil emulsions may increase with increase in the proportion of the aqueous phase.—D. B. **Macleod**: On the viscosities of liquids at their boiling-points. Boiling-points are unsatisfactory temperatures at which to compare the viscosities of liquids. By correcting the boiling-points to a condition of equal free space, the viscosities of liquids become proportional to their molecular weights in the liquid state. Such a condition of equal free space corresponds very closely to a reduced temperature on the basis of Van der Waal's equation of state.—D. B. **Macleod**: The kinetic theory of evaporation. It is assumed that the ratio of the density of the vapour above a liquid to the density of the liquid is really the ratio of the number of molecules with sufficient speed to escape from the liquid to the number with insufficient speed. Thus if D_v and D_e are the densities of the vapour and liquid respectively, then

$$\frac{D_v}{D_e}=\frac{N_s}{N_i},$$

where N_s is the number of molecules with sufficient speed to escape and N_i the number with insufficient speed. It is shown that the results which follow from this assumption are so simple and satisfactory as to make the truth of the assumption extremely probable. The experimental data used are those given by Ramsey and Shields.—J. T. **Howarth** and F. P. **Burt**: New design for apparatus to measure the coefficient of deviation from Boyle's law and the determination of this coefficient for acetylene. A modified apparatus for measuring the compressibility of gases has been designed in which the whole volume of the gas and also the mercury column which registers the pressure are kept at the temperature of melting ice. The coefficient of deviation from Boyle's law at 0° C. for acetylene between 0 and 1 atmosphere is −0·00884.

MANCHESTER.

Literary and Philosophical Society, December 2.—T. A. **Coward**: Migration may be visible or invisible. The passage of large bodies of waders, and of swallows, martins, and swifts during daylight, are examples of visible migration; but the majority of species pass unseen in favourable circumstances, probably because they travel at night or at too great an elevation for human vision. When these species are seen in any numbers, as during unfavourable weather at the coastwise lights, migration is abnormal. The fact that birds frequently travel against the wind or with the wind on a flank does not prove that they prefer this method; nor does the fact that airmen but seldom meet with birds at high altitude annul the possibility of high flight; the birds may have wandered into unfavourable currents. Coasts and river valleys are followed, but there are also cross-country migrations. Wind driftage and contrary currents explain many of the occurrences of migrants in unexpected places.

SYDNEY.

Royal Society of New South Wales, September 3.—Dr. C. Anderson, president, in the chair.—E. **Cheel**: Notes on Boronia in the Pinnate Section, with a description of a new species. The plants, which are from the Richmond River district, have a superficial resemblance to the "Pink Boronia" (*B. floribunda*) of the Sydney district, but the leaves are smaller and the whole plant is more or less hairy and not glabrous, as is the case with "Pink Boronia." The oil contained in the leaves has a fragrant odour, somewhat resembling safrol, and it is therefore proposed to call the new plant *Boronia safrolifera*.—T. **Hodge Smith** and Tom **Iredale**: Evidence of a negative movement of the strand line of 400 feet in New South Wales. A series of sandstone blocks has been trawled along the 70 fathom line from Long Reef, north of Sydney, to south of Montague Island, a distance of about 200 miles. The soundings along this line show coarse sand and rocks, and the boulders are composed of very coarse sand grains similar to that of a beach, and not like the fine soft sand normally found at such depths. One of these blocks was a mass of scallop and other shells cemented together with this coarse sand. The shells belong to littoral species at present living on the coast of Tasmania, while the existing molluscan fauna at the place differs notably in detail from the association of molluscs in this block. These blocks seem to represent an ancient coastline which has been drowned in recent times, probably simultaneously with the movement that broke through Bass Strait.—S. L. **Martin**: The change of resistance of molybdenite due to light. If the contacts are shielded, a strip of molybdenite 0·001 cm. in thickness suffers a decrease in electrical resistance, when light is incident on it, the red end of the spectrum producing the greatest change. This change is constant, providing the current density is less than about 0·1 amp. per sq. cm. and is proportional to the intensity for small intensities. For white light, the source being a hundred candle power pointolite lamp at a distance of 75 cm., the change was of the order of 1 ohm in 500.

Official Publications Received.

Agricultural Research Institute, Pusa. Bulletin No. 153: Tamarind as a Source of Alcohol and Tartaric Acid. By H. N. Batham and L. S. Nigam. Pp. 8+2 plates. (Calcutta: Government of India Central Publication Branch.) 3 annas; 4*d*.

Mysore Geological Department. Records, Vol. 22, 1923. Part 1: Annual Report for the Year 1923. Pp. iii+44. (Bangalore: Government Press.) 1 rupee.

Seconde Assemblée de l'Union Géodésique et Géophysique Internationale, Madrid, Octobre 1924. Espagne. Offert par le Comité Espagnol. Pp. 148+52 plates. (Madrid: Instituto Geográfico.)

Jahrbücher der Zentralanstalt für Meteorologie und Geodynamik. Amtliche Veröffentlichung. Jahrgang 1920. Neue Folge, 57 Band. Pp. xiv+A36+B36+C41+D11+E11. (Wien: Gerold und Komp.)

University of California Publications in Zoology. Vol. 26, No. 4: The Boring Mechanism of *Teredo*. By Robert Cunningham Miller. Pp. 41-80 +plates 3-6. (Berkeley: University of California Press.) 60 cents.

Ministry of Public Works, Egypt: Physical Department. The Discharges and Levels of the Nile and Rains of the Nile Basin in 1919. By Dr. Percy Phillips. (Physical Department Paper No. 11.) Pp. vi+84+3 plates. (Cairo: Government Publications Office.) 5 P.T.

British Scientific Instrument Research Association. Sixth Annual Report for the Year 1923-24. Pp. 20. (London: 26 Russell Square, W.C.1.)

Madras Fisheries Department. A Contribution to the Life-History of the Indian Sardine; with Notes on the Plankton of the Malabar Coast. By James Hornell and M. Ramaswami Nayudu. (Report No. 5 of 1923, Madras Fisheries Bulletin, Vol. 17.) Pp. 129-197. 14 annas. Report on the Inspection of Pearl Banks in the Gulf of Mannar and Palk Bay in March and April 1923. By James Hornell. (Report No. 6 of 1923, Madras Fisheries Bulletin, Vol. 17.) Pp. 199-214. 3 annas. (Madras: Government Press.)

United States Department of Agriculture. Department Bulletin No. 1249: Food Habits of some Winter Bird Visitants. By Ira N. Gabrielson. Pp. 32+5 plates. (Washington: Government Printing Office.)

Agricultural Experiment Station, Michigan Agricultural College. Special Bulletin No. 133: Fertilizers; What they Are and How to Use Them. By M. M. McCool and C. E. Millar. Pp. 26. Special Bulletin No. 134: Greenhouse Insects. By E. I. McDaniel. Pp. 75. Special Bulletin No. 135: Seasonal Management for Commercial Apiaries. By Russell H. Kelty. Pp. 58. (East Lansing.)

Diary of Societies.

SATURDAY, DECEMBER 13.

MIDLAND INSTITUTE OF MINING ENGINEERS (at Danum Hotel, Doncaster), at 2.15.—J. H. Cockburn: Mines (Working Facilities and Support) Act, Pt. I., 1923.—Dr. J. Herezegh: The Collieries of the First Danube Steam Navigation Co.—J. C. F. Statham: The Utilisation of Waste Heat and Surplus Gas from Coke Ovens.

PHYSIOLOGICAL SOCIETY (at Middlesex Hospital), at 4.—T. Lumsden: A Simple Method of recording Respiratory Movements.—D. E. Bedford and S. Wright: Venous Pressure in Man.—J. R. George and J. H. Woodger: Some Points in Connection with the Cytology of the Pancreas.—J. H. Woodger: The Early Germ Cells of the Fowl Embryo.—C. Russ: An Instrument which is set in Motion by Vision or by Human Proximity.—Prof. Swale Vincent: The Effects of Fatigue on the Adrenal Bodies.—S. L. Baker: Demonstration of Lesions in the Human Pancreas.—W. M. Clifford, Gladys Hartwell, and V. H. Mottram: A Stethograph for Student Use.—T. Lumsden: Tracings showing the Effect of Bulbar Anæmia on the Respiratory Rhythm.—T. I. Bennett and E. C. Dodds: The Effects produced by the Assimilation of Large Amounts of Glucose.—Prof. J. Mellanby: Secretin and Pancreatic Juice.—J. W. Pickering and R. J. Gladstone: The Coagulability of Hæmophilic Blood.—W. J. O'Donovan and D. T. Barry: Different Types of Venous Pulse in Health.—B. P. Babkin: Reflex Hyperglycæmia.—Ff. Roberts: The Output of the Heart with Circulation Short-circuited.—J. H. Crawford: The Action of Sparteine Sulphate on Experimental Fibrillation of the Auricles.—Gladys Hartwell and V. H. Mottram: Recovery from a Period of Malnutrition in the Growing Animal.—E. D. Adrian: The Chronaxie of Ventricular Muscle.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section (at Municipal College of Technology, Manchester), at 7.—F. W. Rowe: The Value of Technical Information in Foundry Work.

HULL ASSOCIATION OF ENGINEERS (at Hull Municipal Technical College), at 7.15.—J. Key, Jr.: Autogenous Welding (Lecture).

MONDAY, DECEMBER 15.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—F. C. Raphael and others: Discussion on The New Wiring Regulations of the Institution.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—G. Rogers: Automatic and Semi-automatic Mercury-vapour Rectifier Substations.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates Section), at 7.—E. G. Davies: Some Aspects of Works Management, with a View to Cutting Costs of Production.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—A. J. Davis: Shop Fronts and their Treatment.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. L. J. Russell: Science and Philosophy.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Major R. E. Cheesman: The Deserts of Jafura and Jabrin.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scotland Section) (at Royal Technical College, Glasgow).

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court).

TUESDAY, DECEMBER 16.

ROYAL DUBLIN SOCIETY, at 4.15.

ROYAL STATISTICAL SOCIETY, at 5.15.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Dr. T. E. Stanton: Report on the Measurement of the Pressure of the Wind on Structures.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—E. G. Warne: Development of Steam and of Oil Engine Machinery for Propulsion.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at 17 Albert Square, Manchester), at 7.

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 15 Savoy Street, W.C.), at 7.—Further Particulars and Demonstrations of Recent Advances in Electric Lamps and Lighting Appliances, based on the Report presented at the Opening Meeting on November 18 (with special reference to Shop-window Lighting).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. D. Johnston: A Winter Holiday.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—J. Dunlop: The Internal Combustion Locomotive.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Rev. H. W. Williams: Some Customs, Beliefs, and Traits of the Maori.

WEDNESDAY, DECEMBER 17.

SOCIETY OF GLASS TECHNOLOGY (London Meeting), at 2.30.

ROYAL METEOROLOGICAL SOCIETY, at 5.—C. E. P. Brooks: The Problem of Warm Polar Climates.—Sir Napier Shaw: Winds and Temperature in a Dry Atmosphere.

LONDON AND PROVINCIAL ANTI-VIVISECTION SOCIETY (at Victory House, Leicester Square, W.C.), at 5.30.—Dr. H. F. Woods: Cancer Research and Why it Fails.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. J. D. Falconer: The Geology of Nigeria (Lecture).

NEWCOMEN SOCIETY (at 17 Fleet Street, E.C.), at 5.30.—E. A. Forward: The Development of the Cylinder Boring Machine.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—H. C. Reeves: Mangahao Hydro-electric Power-station.

BRITISH SOCIETY OF MASTER GLASS-PAINTERS (at Art Workers' Guild, 6 Queen Square, W.C.), at 6.—B. Rackham: The Stained Glass at the Victoria and Albert Museum.

RADIO SOCIETY OF GREAT BRITAIN (Annual General Meeting) (at Institution of Electrical Engineers), at 6.—C. F. Elwell: Photo-electrics (Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.—Prof. G. W. O. Howe: World-wide Radio Telegraphy (Faraday Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.

ROYAL MICROSCOPICAL SOCIETY, at 7.45.—Dr. F. W. R. Brambell: The Part played by the Golgi Apparatus in Secretion and its Subsequent Re-formation in the Cells of the Oviducal Glands of the Fowl.—Prof. Ekendranath Ghosh: A New General Classification of Protozoa.—Dr. R. J. Ludford: Further Notes on the Demonstration of the Golgi Apparatus by Osmium Impregnation Methods.

INSTITUTE OF CHEMISTRY (London Section), at 8.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (Annual Meeting) (at Royal Society of Medicine), at 8.30.—Dr. J. Rickman: The Development of the Psycho-Analytical Theory of the Psychoses.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Section) (at Chamber of Commerce, Birmingham).

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Section).

THURSDAY, DECEMBER 18.

LINNEAN SOCIETY OF LONDON, at 5.—Major T. F. Chipp: The Fruiting of the Groundnut, shown in lantern slides.—E. J. Collins: The Physiological Aspect of Blight Infection (*Phytophthora infestans*) of Potatoes.—W. P. Westell: Remarkable Form of *Pastinaca sativa*, new to Britain.—Major R. B. S. Sewell: A Study of the Andaman Sea Basin.

ROYAL AERONAUTICAL SOCIETY, at 5.30.—A. R. Watson Watt: Recent Studies on Radiotelegraphic Atmospherics.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—D. Murray: Speeding up the Telegraphs: A Forecast of the New Telegraphy.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates Meeting) (at Watergate House, Adelphi), at 7.30.

INSTITUTE OF CHEMISTRY (Belfast and District Section) (at Queen's University, Belfast), at 7.30.—Dr. R. C. Johnson: The Rutherford-Bohr Atom from a Chemical and Physical Standpoint.

CHEMICAL SOCIETY, at 8.—W. H. Patterson and J. Duckett: A Method of Determining the Presence or Absence of Complex Salts or Ions in Dilute Aqueous Solutions. Dr. C. K. Ingold: The Nature of the Alternating Effect in Carbon Chains. Part I. The Directing Influence of the Nitroso-group in Aromatic-substitution.—Dr. C. K. Ingold and S. D. Weaver: The Additive Formation of Four-membered Rings. Part VI. The Addition of Azo-compounds to Ethylenes and some Transformations of the Dimethylene-1:2-di-immine Ring.—F. R. Goss, Dr. C. K. Ingold, and Prof. J. F. Thorpe: The Chemistry of the Glutaconic Acids. Part XVII. Three-carbon Tautomerism in the Cyclopropane Series. Part 4.—Dr. C. K. Ingold: The Condition Underlying the Formation of Unsaturated and Cyclic Compounds from Halogenated Open-chain Derivatives. Part IV. Products derived from Halogenated α-methyl Glutaric Acids.

SOCIETY OF DYERS AND COLOURISTS (West Riding Section).—J. W. Radcliffe: The Blending of Materials in the Woollen Trade with relation to Dyeing.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Section).—Prof. F. C. Lea: The Effect of Low and High Temperatures on Materials.—J. M. Lessells: The Elastic Limit in Tension and its Influence on the Breakdown by Fatigue.

FRIDAY, DECEMBER 19.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Report of the Wire Ropes Research Committee.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section, jointly with Institute of Chemistry) (at Chamber of Commerce, Swansea), at 6.30.—Prof. R. V. Wheeler: Fire Damp Explosions (Lecture).

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section) at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group) at 7.—R. H. Lawton: Specialisation *v.* Versatility.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-on-Tyne), at 7.—Discussion: Steam *v.* Electric Auxiliaries.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates Meeting) (at Watergate House, Adelphi), at 7.30.—H. E. Merritt: Tooth Gearing.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-upon-Tyne), at 7.30.—J. L. Taylor: Theory of Longitudinal Bending of Ships.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Cleveland Institution, Middlesbrough), at 7.30.—Dr. E. V. Telfer: Technique and its Acquisition in Shipbuilding.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Col. the Master of Sempill: Aircraft in Japan.

SOCIETY OF DYERS AND COLOURISTS (Midlands Section) (at Municipal Technical School, Leicester).—S. R. Trotman and R. W. Sutton: The Destruction of Wool by the Action of the Atmosphere.

SOCIETY OF DYERS AND COLOURISTS (Scottish Section).—J. W. Wilson: Celatine Colours and their Application.

PUBLIC LECTURES.

SATURDAY, DECEMBER 13.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: The Glory that was Thebes.

TUESDAY, DECEMBER 16.

ROYAL BOTANIC SOCIETY OF LONDON, at 3.—Prof. Bickerton: The Correlation of Science (3). Waves and Vibrations.

KING'S COLLEGE, at 5.30.—M. Kaye: F. H. Bradley—The Absolute and Human Personality.

NATURE

SATURDAY, DECEMBER 20, 1924.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2877, VOL. 114]

River Pollution.

ONE does not need to have read the "Compleat Angler" to know that fishing is among the most humanising of crafts. Up and down the country in all possible — and in some impossible — places, gentle patient citizens will be found practising the art. If they catch fish, so much the better: if not, they have been in pleasant places and communed with peace; like the small girl whose pet pigeon had flown away, fishermen "adore hope," and no one can doubt that they are the better for it. With them we have to think of the other gentle men, the field naturalists, who, whether their particular pursuit be rotifers, or snails, or plants, or what not, have one of their happiest hunting grounds in and by our rivers and streams, and steadily go on adding up our sum of natural knowledge.

Besides these craftsmen there are the people who find in the activity of running water the rest and comfort that their souls need and walk by the river just because it is beautiful, and they find that it does them good. They may all well wonder why fish and animalcules and peace should be allowed to disappear together in the filthy sewers which stand for the Wear in the gorge at Durham, or for the Mersey in the lovely Marple valley. Incidentally too, as we learn from the "Report of the Proceedings under the Salmon and Freshwater Fisheries Acts for the years 1922 and 1923,"[1] the salmon caught in the Herefordshire Wye in 1923 had a selling price of 15,000*l.*, those from the Tees of 28,000*l.* It is not suggested that all the rivers in Great Britain are potential salmon fisheries, but there are evidently commercial considerations in favour of biologically clean streams.

The problem of river pollution is one of the problems of industrialisation. Pollution comes mainly from two sources—domestic sewage and industrial wastes. The former is seldom now discharged into rivers in a crude state except from quite small communities: modern methods of sewage purification are efficient and quickly increasing in efficiency as the principles of biological defæcation become better known, and if domestic sewage were all there was to deal with, clean rivers would appear to be well within reach. But a town's sewage often contains, in addition, trade wastes and effluents which hamper and retard the purification of the domestic excreta by poisoning the live things on which that depends, and they act equally harmfully on the flora and fauna of the rivers into which they find their way. Often, too, large works of one kind or another will pour their undiluted wastes into a stream and kill everything that is alive in it. In milder cases these

[1] Ministry of Agriculture and Fisheries (H.M. Stationery Office, 1924). 3s. The Ministry has also published a useful booklet, "River Pollution and Fisheries," price 3*d.*

effluents may produce surprisingly large effects by their action on some specially sensitive member of the fauna or flora: in this way the self-regulation of the aquatic communities is upset and deterioration spreads all through the ecological complex.

Among the more sensitive of the large and familiar animals are salmon and trout, which demand a very high degree of purity and oxygenation in their water: in the hotter months, indeed, it seems that trout must often be living near the margin of the oxygen supply that they will tolerate, and under these conditions a slight degree of extra pollution may turn the scale against them. There is, however, too great a tendency to think of the question in terms of these "sporting fishes": they are the pastime and refreshment of the few, and in reality coarse fish are a good deal more important, if only because there are many more of them and many more people anxious to take their chance of catching them.

What is being done to purify the foul rivers and prevent further contamination? The old pollution Acts have evidently failed even to stop matters getting rapidly worse in recent years. In 1921 a Standing Committee on Rivers Pollution, composed mostly of persons directly interested in fisheries, was set up, and in 1922 it commenced, under the energetic superintendence of Dr. E. C. Jee, of the Ministry of Agriculture and Fisheries, a survey of selected rivers in Great Britain.

A good deal of progress has already been made with this survey, and valuable information has been obtained as to the actual degree of pollution, its sources and effects. Specific tests of the poisonous action of effluents on fish are also carried out at the Ministry's little station at Alresford, where the problem of tarring roads with safety to the neighbouring watercourses was so successfully solved. More immediately useful still, committees have been got together in the different fishery districts where the local interests and knowledge of anglers and manufacturers are combined to deal directly with local problems. To aid the Standing Committee in the more technical chemical and biological questions which arose, a Scientific Advisory Committee was added in 1924.

Through this organisation the most essential step towards reform has been taken and much has been done to rouse general interest in the subject. In 1923 a new pollution Act, after many vicissitudes and delays, received the Royal assent. Under this, it is an offence to cause pollution of any waters containing fish of any kind so as to render such waters poisonous or injurious to fish or to their spawning grounds, spawn or food. It is an obvious defect that the Act permits the unrestrained pollution of waters which do not contain fish, and it also allows as a defence of existing pollution the plea that "the best practicable means within a reasonable cost" have been employed to prevent it.

Legislation, in short, follows the lines to which we are accustomed in Great Britain. We do not say, as does New York, "smoke is forbidden" and make that the beginning and end of it: we prefer to dally with discussions of "brown" smoke and "black" smoke and put up with dirty towns. In the end, perhaps, we get the right result on a permanent basis backed up by a convinced public opinion, but this takes a long time. More drastic powers might well have been obtained to deal with difficult manufacturers who naturally affirm, to begin with, that any steps towards purification would ruin them, though they may end up by finding that cleansing their effluents may yield saleable products more immediately remunerative than the blessings of the community.

In these several ways, then, the *ad hoc* problems are beginning to be dealt with. But we feel that progress will soon get slow unless steps are taken to promote our knowledge of the fundamentals of river life. It needs no scientific training to be sure that the Tyne in its lower parts is not what it should be, and no more than a sanitary inspector's acumen to trace the trouble to its sources. But all experience tells us that empiricism of this sort will take us only a certain way. Even now it can make no serious attempt to explain why in the smaller Hertfordshire rivers, for example, fish of all kinds have almost disappeared in the last ten years, leaving the streams to casual inspection reasonably clean, bright and weedy.

Fresh water ecology has scarcely been thought of in Great Britain, and it offers an open field to workers of many kinds to help to work out how the complex communities of plants and animals live and move and have their being, and what are the conditions which determine their stabilisation at different levels. To take the crudest example, the foods of fishes and the foods of this fish food are simply not known any more than, until recently, were the foods of our birds known. There is also great ignorance as to what exactly various degrees of pollution of different kinds do, what chemical changes are produced in the water, and which components of the fauna and flora are affected and how.

Beginnings in a small way are being made in various places, but what is most deeply needed is an institution round which this work could centre. There are a few marine biological stations, but there is no corresponding focus for fresh-water work. No one interested in fishing or in the amenities of the countryside could do better than to provide such a station for investigating the conditions of life in the rivers and streams of Great Britain.

Physiological Optics.

Helmholtz's Treatise on Physiological Optics. Translated from the third German edition. Edited by Prof. James P. C. Southall. Vol. 1. Pp. xxii+482. (Published by the Optical Society of America, 1924. To be obtained from Prof. F. K. Richtmyer, Cornell University, Ithaca, New York.) 7 dollars.

Let us now praise famous men.
The Lord manifested in them great glory,
Even His mighty power from the beginning.
Such as did bear rule in their kingdoms:
And were men renowned for their power,
Giving council by their understanding:
Such as have brought tidings in prophecies;
Leaders of the people by their councils,
And by their understanding men of learning for the people.
Wise were their words in their instructions.

Ecclesiasticus, 44, 1-6.

THREE years ago the Optical Society of America celebrated the centenary of the birth of Helmholtz and decided that a lasting commemoration should be established by the publication of an English translation of his great book on physiological optics. So at last a deep reproach has been lifted from the record of English scientific literature. "The very existence of this book in English," says the editor of the translation, "should lead to new treatises and new text-books, which are sorely needed at present." The third German edition, containing the text of the first edition with supplements added later by Helmholtz himself, by the late Prof. Nagel, and by Profs. Gullstrand and v. Kries, was chosen for translation. The present volume is enriched by six of Helmholtz's supplements, three of Gullstrand's notes, and six appendices by Gullstrand. Special interest is given by the inclusion, as the sixth appendix, of a chapter on ophthalmoscopy taken from Prof. Gullstrand's work on dioptrics. This is one of the features which gives distinctiveness to the English edition, for it did not appear in the third German edition.

The name of Helmholtz is outstanding in science as that of an original investigator and breaker-out of new paths in several directions, and as that of a man of rare genius whose work was of epoch-making quality. In this respect his "Physiological Optics" stands amongst such works of the last century as the magnificent fragment known as Thomson and Tait's "Treatise," or Maxwell's "Electricity and Magnetism." It is well that it should be placed alongside them in its English garb. The stamp of endurance marks it out as the work of one who, to use his own words regarding Young, was "leaping before his time." The present volume teems with examples of the permanence of its value and the manner in which modern work forms its fitting development.

No new treatise, say the German editors, has superseded Helmholtz's work—it

"bears the stamp of a genuinely classical treatise which will always retain its value, even if new investigations lead to some modifications here and there of the points of view which Helmholtz himself entertained." "In the theoretical and for the most part solid territory belonging to the physiology of both the sensations and the perceptions of vision, the editors considered . . . that even where it was necessary to record a notable advance of scientific investigation since the date of the appearance of the first edition of the Physiological Optics, a natural outcome of this kind should not involve at all an adverse attitude towards the theories of Helmholtz."

The foremost reason given for the decision to republish the text of the first edition

"was the consideration that the whole imperishable significance of Helmholtz's achievements in the domain of the physiology of vision, the elegant physical methods which he adopted and improved, his painstaking observations of the sensations themselves and the allied psychical phenomena, the mathematical analysis and philosophical and critical discussion, all these characteristic features are essentially interwoven with the first edition of the Physiological Optics. It is the classical work which marked the dawn of a new era in the science of the physiology of the senses."

Another reason which is also given does not apply to the subject matter of the first volume. Whatever exception may be taken to the view involved in it, there will probably be no difference of opinion regarding the wisdom of the conclusion. The great extent and invaluable nature of the supplementary work included in the third German edition left to the translators no other choice than that of its adoption by them. The bulk of the new matter published in the first volume almost equals that of the original matter, and it deals with every division of the subject.

The aim and the hope of Helmholtz in undertaking his work was clearly stated by him in his first preface. "An effort had to be made to introduce law and order in this region and to rid it of the curious contradictions which have heretofore impeded progress. I have proceeded on the conviction that law and order, even if they are not fundamentally sound, are better than contradictions and lawlessness." "I trust that competent judges will bear in mind the difficulty and intricacy of the problem to be solved when they are disposed to find fault." These defects were the rank growths against which he raised his axe: and in pioneer work "a man was famous according as he had lifted up axes against the thick trees." The true pioneer possesses the sense of direction; he rarely misses his aim or even takes a wrong detour. The

extent to which this was true of Helmholtz is apparent throughout this volume.

Helmholtz treated the whole subject under three headings: (1) the theory of the path of the light in the eye, (2) the theory of the sensations of the nervous mechanism of vision, (3) the theory of the interpretation of the visual sensations. It is with the first of these that this volume deals. The magnitude of the new work in dioptrics is so great that its limitation to nearly the same bulk as that of the original treatment has only been attained by the omission of the mathematical proofs. For these the reader has to refer to Prof. Gullstrand's original papers. Yet that will perhaps be found by the majority of readers to be no disadvantage. In this way the line of argument is more lucid and the presentation more concise. It suits the requirements of most ophthalmologists and is not without advantage to the student of physics. The editor of that subject

"has endeavoured to limit himself mainly to the essential facts in the region where notable advances have taken place, and to present these modern ideas in as simple a form as possible for a reader who is not versed in higher mathematical analysis. An outline of the new theory is given here for the first time, including the previously unknown laws of optical imagery in media of variable index of refraction which could not be omitted because, first of all, they are essential for finding the data of a schematic eye that will agree with the facts as they are now known, and also because these considerations are of importance in connection with the effort to substitute a new theory of accommodation in place of Helmholtz's theory, whereas undoubtedly this attack as well as others of a similar kind are to be regarded as affording new supports to the author's views on this subject."

In practical ophthalmology, Helmholtz's instrument, improved no doubt, is still the one in use. "The ophthalmologist who uses the ophthalmoscope every day . . . knows best how to estimate Helmholtz's immortal service to mankind." Its use in various forms and for various purposes is treated fully by Gullstrand. One of his notes refers to the solution of a problem, "which could not even have been proposed at the time when the ophthalmoscope was invented." The advantages and disadvantages of the several modifications are discussed.

The value of Gullstrand's contributions may be judged from the fact that, previous to his work, the optical laws of the formation of images were only worked out under highly limiting conditions which prevented the results from having application to the problems of imagery in the eye. Very high approximation to correct results could be got by laborious calculations, so that the construction of optical instruments possessing axial symmetry was highly developed. But physiological optics requires, for the sufficiently accurate solutions of its problems, that the conditions shall be much wider than those imposed in normal optical construction. Therefore Gullstrand determined the general laws of optical imagery, and then, applying them to the practical problems of vision, gave a fresh illustration of the further development of one science in consequence of the expansion of another. The beautiful tale is told in his appendices. His work is worthy of a position beside that of the master.

All through this volume may be found references to the value of the master's work.

"If the form of the cornea is to be calculated by means of relations that are true for an ellipsoid, undoubtedly the best way is to go about it regularly and to calculate the constants of the ellipsoid by the method given by Helmholtz."

"Although more recent investigations tend to give rather lower values, there hardly appears to be any sufficient reason as yet for modifying Helmholtz's schematic value beyond merely discarding the figure in the fourth decimal place as not being at all certain."

"Unless a Blix ophthalmometer is available, Helmholtz's method of ascertaining the positions of the surfaces of the crystalline lens is still to-day the best method."

"If the sources of error are taken into account, depending on the asymmetrical flattening of the cornea, on the unknown form of the anterior surface of the lens, and on using a total index for the index of refraction of the lens, there can be no doubt that Helmholtz's number is within the possible limits of error." "The same conclusion has been reached also concerning the radii of curvature of the two surfaces of the lens."

"Modern investigations have established that the theory of the mechanism of accommodation remains unchanged, in all essential features, just as Helmholtz, by a real inspiration of genius, considering the state of knowledge of that time, conceived it."

An example of misconception of Helmholtz's view is discussed in the fourth appendix.

"Helmholtz's own words are: 'Stretched elastic membranes which contain an invariable volume of an incompressible fluid, and which are attached by a circular margin, as the zonule is to the choroid, tend to approach the form of a segment of a sphere in proportion as its tension increases. . . .' To infer from this that the anterior surface of the lens, as it bulges forward with a decrease of tension in accommodation, is obliged to approach the form of a sphere, so that an increase of curvature can be produced by the increase of tension, involves conceptions that are incompatible with the mathematical knowledge of a Helmholtz."

A second misconception is considered.

"Helmholtz's famous dictum, that the monochromatic aberrations of the eye are such as would not be tolerated in any good optical instrument, is sometimes construed to mean that the eye is a very badly constructed optical affair—which Helmholtz never said

and certainly did not mean. But another question that this statement raises is whether these aberrations are not serviceable and what is their purpose. . . . The monochromatic aberrations are a witness for the perfection of the eye, if what is meant by the perfection of an optical instrument is good convergence of the rays to the degree that is needed to obtain the greatest useful sharpness of image, anything in excess of this being sacrificed in order to gain some other end."

Unfortunately, these two misconceptions regarding Helmholtz's views do not stand alone.

The American Optical Society, the editor with his collaborators, and the printers are alike to be congratulated on this issue of an epoch-making book, worthily worked up to the level of modern knowledge. It is the most suitable memorial which could have been raised to the memory of Herman v. Helmholtz, physicist, physiologist, and mathematician. The reward of the contributors to the German and the American issues will be forthcoming if the response for which the editor hopes comes in the way of new advances. This volume should be at the disposal of every worker who is specially interested in optics in its purely physical, its physiological, or its ophthalmological bearings.

W. PEDDIE.

Phylogeny as an Independent Science.

Geschichte der Organismen. Von Prof. Victor Franz. Pp. xiii+948. (Jena: Gustav Fischer, 1924.) 36 marks.

THE author of this ponderous work is the occupant of a chair of "phylogeny" in the University of Jena, and in this volume he has apparently attempted to justify his position, for he treats of the evolutionary history of every phylum both in the animal and in the vegetable kingdom! Both the title of the chair and of the book must awaken amazement in simple British minds. What is phylogeny apart from zoology and botany? Is not the specialist in botany or in zoology the only person competent to construct even a plausible phylogeny in either science? But perhaps we might expect in a volume like this to find the foundations for phylogenetic hypotheses critically examined: we might hope to have the value and the limitations of the evidence from fossils discussed; the theory of recapitulation explained and its validity determined. Such questions seem suitable for a book by a professor of phylogeny in general. If such were our expectations we should be bitterly disappointed. The book opens with a chapter devoted to a sketch of the physical geology of the globe and the changes which sea and water have undergone since the Cambrian. Then follows an account of the Darwinian theory of evolution with references to De Vries's mutations, Mendelism, and to direct adaptation and Lamarckism. The discussion on evolution is succeeded by a section on "Body and Soul" (Körper und Geist) in which we are informed by Prof. Franz that when the body dies, the "ego" is dissolved (how does Prof. Franz know this?), but that the "psychical" (whatever this may mean) persists. After this we reach a section dealing with the supposed characters of the first living beings and the manner in which they were derived from inorganic matter. Then we plunge into the detailed phylogenies of the various classes, first of plants and then of animals.

Now, no reviewer—least of all the present one—could possibly claim to be a competent judge of the plausibility of all these hypothetical phylogenies, and so we have tested their general value by looking critically at those in which we were most familiar with the evidence, namely, those contained in the invertebrate section of the animal kingdom. We may, however, remark in passing that some of the botanical theories seem to us extraordinary. Because its sexual germ-cells (oospores and antherozooids) resemble the ova and sperm of animals, the brown alga Fucus is regarded as closely resembling the original primitive organism from which all the rest, both animals and plants, have sprung. Consequently the unicellular protozoa are regarded as secondary degenerations of multicellular ancestors, and isogamy or the union of similar gametes is derived from the fertilisation of an egg by a spermatozoon. Verily all things are possible to him that believeth! We can only say that Prof. Franz's taste in these matters is widely different from our own. We might remind Prof. Franz that amongst the most primitive type of animal, namely, Amœba and its allies—the Foraminifera—isogamy is the rule, and that typical ova and spermatozoa are not encountered until we reach the sponges. But perhaps the most relevant criticism of theories such as these is that until the postulates underlying the construction of phylogenies are discussed and explained, one theory is really as good as another.

Turning now to the account given of the phylogeny of the principal invertebrate stocks, we can only characterise most of them as most unsatisfactory and based largely on lack of knowledge of the most recent researches. Thus the Turbellarian worms are termed "cœlomate" because they possess distinct genital organs and a cellular mass termed "mesoderm" between skin and gut lining, though no vestige of a true cœlom can be detected at any stage in their life-history. Not a word is mentioned of Lang's brilliant theory of their derivation from Ctenophora, though this theory has acquired strong support from

the discovery of creeping Ctenophora like Ctenoplana, and of a true ctenophore larva in the life-history of Coeloplana which in its adult condition closely resembles a turbellarian worm. When we turn to the chapter dealing with the phylogeny of the Crustacea, we find the Nauplius larva, which appears in the life-history of so many Crustacean stocks, and evidently represents in some disguise or other a common ancestor, regarded as representing a "metatrochophore" stage of the annelidan ancestor. But Walcott in his account of the mid-Cambrian fauna of British Columbia has described primitive arthropods which may well have been the actual "Nauplius" ancestor in the flesh. Such is "Marella," which in general structure is a shortened trilobite carrying attached to the hinder part of its body the foliaceous appendages characteristic of Trilobita; but the first three segments carry elongated limbs corresponding to the Nauplius appendages. Prof. Franz, in seeking for light on the ancestry of a group in the structure of a larva, neglects altogether to discuss the *simplification* of ancestral structures in the larva and its meaning and significance, so that in regarding one structure as primitive and another as secondary, he seems to proceed in an altogether arbitrary manner.

As another good example of superficial and crude reasoning based on lack of knowledge of recent work, we may refer to Franz's account of the phylogeny of the Echinodermata. The cystids are regarded as the ancestors of the whole group. It is admitted by all that the cystids developed into the crinoids, which they resemble in possessing a dorsal stalk and a lateral anus. But Franz derives from them also the whole of the Eleutherozoa (starfish, sea-urchins, and sea-cucumbers) in which the place of the aboral stalk is occupied by the anus. Of these the sea-cucumbers, supposed to be the most primitive, are stated to have branched off earliest from the cystidean ancestor, then the sea-urchins, and lastly the starfish. But if a cystid (of the internal anatomy of which we of course know nothing) really was like a crinoid in its soft structures, then it must have been widely different from the common ancestor of the Eleutherozoa. For in all three divisions of these, the central axis of the genital system, the so-called "genital stolon," is closely associated with the primitive stone-canal, whereas in crinoids these two structures are entirely separated and have no relation to each other whatever. The anus in primitive Eleutherozoa is always close to the aboral pole, and the course of the alimentary canal shows no resemblance to the spiral gut of crinoids.

Prof. Franz refuses to accept the identification of the "sucker" of attachment of many of asterid larvæ with the attachment of the stalk of the crinoid. Here again is evidence of unawareness of modern work, for, as Bury first showed, the Crinoid larva exhibits a rough correspondence in its organs with the Bipinnaria larva of the Asteroidea. Now in both larvæ the "sucker" of fixation is of exactly the same form and is developed at the same place. It comes to occupy totally different positions in the adult bodies of the two groups on account of the different character of the metamorphosis in each case. These different metamorphoses point strongly to a primitive divergence in habits between the ancestors of the two groups which led to their separation long before even the simplest cystoid form had been attained. If we now turn to the development of the sea-urchins, we find that the young sea-urchin begins its post-larval life in a form which is to all intents and purposes that of a starfish, and that the globular form is only gradually attained as growth proceeds. Thus we see how ill-founded is Franz's comparison of the cystid and the echinoid because both have a spherical shape.

When we reach the part of the book dealing with vertebrata, there is of course less opportunity for the presentation of crude ideas since the palæontological history of the vertebrate is relatively so well known. Yet even here the author seems totally unacquainted with recent embryological work which tends to establish the lateral fold theory of the paired limbs beyond all reasonable question; and commits himself, though with some hesitation, to the exploded theory of Gegenbaur that the limbs arose from displaced gill-arches.

Whilst, however, we regard Prof. Franz's methods of dealing with phylogeny as mistaken, and lament the absence of any attempt to set forth and defend the principles on which phylogenetical reasoning must be founded, yet the reader will find—especially in the part devoted to vertebrata—a large collection of useful facts amongst which the data which have been brought together throwing light on the origin of our domestic animals are particularly valuable. E. W. M.

The Electricity of Thunderstorms.

Die Elektrizität der Gewitter. Von Dr. K. Kähler. (Sammlung Borntraeger, Band 3.) Pp. 148. (Berlin: Gebrüder Borntraeger, 1924.) 4*s.* 9*d.*

ONE must congratulate German science on the large number of useful monographs which are constantly being published in Germany. When a branch of science has been advanced by independent original research in all parts of the world, it is highly desirable that every now and then we should be able

to review the progress made, and a monograph which collects all the threads together and sets them out as a more or less completed fabric not only achieves this but also gives an extremely pleasant form of reading to those working at the subject. The book before us is a good example of this type of literature, and is therefore to be welcomed.

The contents of the book are divided into two parts: Part I. deals with the observational facts and Part II. with the various explanations which have been offered from time to time of the electricity of thunderstorms. Throughout full references to the literature are given, and this alone makes the book of great value to the original worker in this field of science. Although the literature is now very large, we have not noticed any important omissions except in one case, namely, the omission to mention C. T. R. Wilson's outstanding paper, "Investigations on lightning discharges and on the electric field of thunderstorms," which appeared in the Philosophical Transactions in 1920. We feel sure that the author has not seen this paper, otherwise he could not have failed to quote many of the important results contained in it.

There is not much to say about the first part of the book, as it deals mainly with facts which are now fairly well known and generally accepted. Mohn's classification of thunderstorms as *Wärmegewitter* and *Wirbelgewitter* is shown to be well founded. In *Wärmegewitter*, which are called heat-thunderstorms in Great Britain, the energy is derived from temperature instability in the vertical direction, generally produced by intense solar radiation warming up the lower layers faster than the ordinary processes of convexion and turbulence can distribute the heat to the upper strata, although a similar effect can be obtained when air passes over a relatively warm sea surface. In the second type, the energy is derived from warm and cold currents which are brought side by side, generally in consequence of the circulation associated with cyclones. The thunderstorms associated with "line-squalls" are typical of this class, but we have no special name by which to describe them in English.

Besides a fairly full discussion of the meteorology of thunderstorms, Part I. contains a description of the electrical conditions observed, together with short accounts of the different forms of electrical discharges.

While the first part is probably the most valuable, the second part will, we think, be read with the most interest by many physicists. In it Dr. Kähler reviews some of the explanations which have been put forward to account for the origin of the electricity in thunderstorms. To discuss all would of course be impossible, for they are literally legion. It is interesting to see the large number of physical processes which have been used at one time or another in theories which are now finally abandoned, at least by most meteorologists, if not by their authors. Amongst these are cosmical dust; electrical influence from the sun, moon, and stars supposed to be electrically charged; cathode rays from the sun; ultra-violet light from the sun acting on ice crystals; friction between water and ice; differential condensation on positive and negative ions, and absorption of negative ions by falling precipitation. At the present moment there remain only three physical processes which are considered worthy of serious consideration: (*a*) the separation of electricity which takes place when drops of water are broken up in the atmosphere; (*b*) a similar effect produced when solids are brought into contact and then rapidly separated, the electrification of dust being a good example; and (*c*) influence charges produced on the precipitation by the electrical field.

In 1909 the reviewer put forward the theory of thunderstorms based on (*a*), which he extended in 1915, making use of (*b*) to explain the electrical phenomena of snowstorms and of thunderstorms in which there is no liquid precipitation. He is still of the opinion that these two physical processes are able to account for all the electrical effects associated with atmospheric precipitation. Dr. Kähler will not go so far as this, but while admitting that both may play some part, he considers that the influence effect is the chief factor at work. Elster and Geitel were the first to suggest an effect due to influence charges, but Dr. Kähler is not satisfied with their scheme and puts forward a modification of his own. This, we think, is the weakest part of his book. The modification of Elster and Geitel's theory which he introduces unfortunately results in a process which can only reduce an existing field; surely a process of this kind is not likely to be the explanation of the high electrical fields which are associated with thunderstorms.

Before closing this review we should like to direct attention to a pleasing aspect of Dr. Kähler's writing. Instead of using the long involved sentences so characteristic of German writings, Dr. Kähler expresses himself in short clear sentences. The average length of the seventeen sentences on a page opened quite at random is only eighteen words. We do not know whether this would be commended by a German of literary taste, but it is certainly very welcome to non-German readers.

G. C. SIMPSON.

Our Bookshelf.

Plants Poisonous to Live Stock. By Harold C. Long. (Cambridge Agricultural Monographs.) Second edition, revised. Pp. vii+120. (Cambridge: At the University Press, 1924.) 8*s.* 6*d.* net.

THE second and revised edition of Mr. Long's book on plants poisonous to live stock contains on the whole but few alterations. There are, however, several additions in the description of individual species, ragwort and bracken in particular, and some minor alterations in the concluding chapter on the classification of poisons.

In the introduction, the poisoning of live stock is dealt with from various points of view. Different species of stock often appear to be affected quite differently by the same plant, and poisonous effects may also vary with the individuality and age of animals of the same species. Some plants do not lose their toxic properties on drying, and therefore cannot be safely fed even with hay. Some also are poisonous in all their parts, such as meadow saffron, whereas in others the toxicity is confined to one part only, such as the seed in corn cockle. Further, soil, climate and cultivation may affect the toxic properties of a given species.

Most of the plants described are British, but foreign species such as "Java" beans, which may be used in feeding stuffs, and some common garden shrubs are also included. Fungi, with the exception of ergot, are not dealt with, though the toxicity of darnel seeds is stated to be due to the presence of a symbiotic fungus. The species are described under their natural orders, examples of poisoning, the toxic principle, symptoms, and references to the bibliography at the end of the book being given in each case.

As in the previous edition, the author also deals with plants suspected of being poisonous, and those affecting milk or causing mechanical injury to animals.

Theoretical Metallurgy. By R. S. Dean. Pp. vii+246. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 15*s.* net.

SCHENCK'S "Physikalische Chemie der Metalle," first published in 1909, broke new ground in metallurgical literature, since it described the application of physical chemistry, not only to the constitution of alloys, a task which had been attempted often, but also to the reactions of the smelting processes and to other technical metallurgical operations. The author of the present work translated Schenck's book some eleven years later, by which time some of the information was out-of-date. In place of preparing a second edition, he has preferred to re-write the book, whilst retaining the main features and many of the details of the original, including illustrations, so that the volume on opening has a familiar look. New subjects, including the structure of metallic crystals as revealed by X-rays, have been introduced, and the work now covers a field of great and general interest.

Unfortunately, the execution is not always equal to the design, and the text is very frequently inaccurate. Mathematical formulæ have suffered badly, as well as proper names, and although the number of references to papers is large, many of them seem to have been selected somewhat at random, investigations of equal or greater importance being overlooked. The sections which deal with steels are inaccurate, especially in regard to hardening. Many subjects receive such brief treatment that the student will derive little from reading those sections. It may be said that the experienced metallurgist will gain many useful hints from the reading of this book, which deals with interesting matters and is simply expressed, but he will need caution, whilst the inexperienced student is likely to be puzzled and confused by its numerous errors.

C. H. D.

The Deluged Civilization of the Caucasus Isthmus. By Prof. R. A. Fessenden. Pp. ix+139. (Boston, Mass.: T. J. Russell Print; London: F. and E. Stoneham, Ltd., 1923.) 25*s.* Large paper edition, 5 guineas.

PROF. FESSENDEN is an ardent advocate of the urgent necessity of archæological exploration in the Caucasus. While archæologists will agree that investigations in this area are likely to afford evidence which will help in the elucidation of a number of problems in the ethnology and archæology of prehistoric and early historic times, they will scarcely be prepared to endorse Prof. Fessenden's arguments, although they may wish him all success in his research. He holds that the Caucasus is the cradle of mankind; that it was there that the flood to which early records refer took place, and that it was thence that the races of mankind dispersed after their differentiation. By an elaborate analysis of Semitic, Egyptian and Greek traditions and of local names, he seeks to show that not only was this the site of Eden, but also that on his assumption it is possible to unravel the inconsistencies in the geography of the Greek legends and explain why, for example, the search for the lost pillars of Hercules towards the west was unsuccessful. The rise of water level in the Caspian area and the formation of an Atlantean Sea of 1800 miles breadth east of the Black Sea were responsible for the disappearance of the country to which the traditions referred and the consequent dislocation of the ancient geographical system. Prof. Fessenden has worked out his case in great detail and with considerable ingenuity. His arguments will be more convincing if, and when, he can produce archæological evidence to support them.

Fluxes and Slags in Metal Melting and Working: a General Discussion held by the Faraday Society and the Institute of Metals, with the Co-operation of the British Non-Ferrous Metals Research Association and the Institute of British Foundrymen, April 1924. Pp. 109-208. (London: Faraday Society, 1924.) 7*s.* 6*d.*

LIKE other general discussions arranged by the Faraday Society, this collection of papers on fluxes and slags brings together a most useful mass of facts known to a limited number of persons, and at the same time brings into relief the need for systematic investigation. In spite of the importance of fluxes in the working of non-ferrous metals, such knowledge of them as exists is almost entirely empirical, and very little has been done to determine the factors on which their efficiency

depends. The fact is brought out in several papers that the interfacial tension between slag and metal determines the separation of non-metallic inclusions, but only in the instance of the formation of metallic "fogs" when fused metals are in contact with their halogen salts have any actual determinations of this important factor been made. In welding and soldering, the efficiency depends on the wetting of the metal by the liquid, as well as on the solvent power of the flux for oxides, but neither the chemical nor the physical factor has been studied in any systematic way. Aluminium, the oxide of which is very difficult to eliminate, has received more attention than most metals, but much of the work remains merely qualitative. The papers, although technical in character, should be of interest to chemists and physicists who are concerned with problems of solubility and of surface tension. The importance of non-metallic inclusions is shown by a study of their influence on the resistance of metals to fatigue, and any work which would tend to lessen the frequency of these undesirable constituents would be of great value to the metallurgical industries.

Tulum: an Archæological Study of the East Coast of Yucatan. By S. K. Lothrop. (Publication No. 335.) Pp. vii+179+27 plates. (Washington: Carnegie Institution, 1924.) n.p.

IN this volume, Dr. Lothrop has placed on record the results of three expeditions of the Carnegie Institution of Washington to the east coast of Yucatan under the leadership of Dr. Sylvanus G. Morley in 1916, 1918, and 1922. The main objective was Tulum, the most important ruin in this region, but other sites also were visited. Dr. Lothrop, however, has not confined himself to the work of these expeditions, but aims at giving a complete account of present knowledge of the archæology of this area by summarising previous publications covering sites not visited on these occasions. The Maya culture of this part of Central America presents certain peculiarities in architecture, art, and religion which mark it off from the rest of Yucatan. Such are, for example, an absolutely new type of building—the shrine, and the sanctuary, the latter occurring in structures here called "palaces," as they appear to have served as residences rather than as temples. The frescoes, of which a large number have survived, are comparable with the drawings of the codices and are regarded by Dr. Lothrop as but little inferior to the Dresden codex which is the high-water mark of Maya art. Dr. Lothrop's detailed and lavishly illustrated account of this localised development of Maya civilisation, and his analysis of its cultural and ethnical affinities, is a contribution to American archæology which will rank high.

Outlines of Medical Zoology: with Special Reference to Laboratory and Field Diagnosis. By Prof. Robert W. Hegner, Prof. William W. Cort, and Francis M. Root. Pp. xv+175. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 11*s.* net.

THE "Outlines of Medical Zoology," which has recently been published by Prof. Hegner and his colleagues in the Johns Hopkins University, is a convenient little book for the use of medical men in the field, and for teachers of zoology in schools and universities where the economic applications of the science are included in the curriculum, but it is too concentrated for the elementary student and not sufficiently detailed in description for those who are seriously engaged in the study or the practice of the subjects. There is, perhaps, some danger lurking in these little books that the student, who has not much time to devote to it, may imagine that he has mastered the subject by learning off the tables and diagnoses by heart. They should only be used after or associated with a course of practical work in the laboratory accompanied by some further instruction in the morphology of the animals described.

We must acknowledge, however, the great care and skill with which the authors of the three parts—on protozoology, helminthology, and entomology—have condensed their wide knowledge and practical experience of their subjects, and recognise that the book will prove to be extremely valuable to many zoologists and medical men.

Theories of Memory. By Dr. Beatrice Edgell. Pp. 174. (Oxford: Clarendon Press; London: Oxford University Press, 1924.) 7*s.* 6*d.* net.

THIS admirable and valuable little book brings together in short compass, but in clear and comprehensible terms, the leading theories of memory, in particular the attempts to give precision and definition to the term "memory-image." Theories of memory, like theories of colour-vision, are baffling to the student in their numerical variety and diversity of principle. Miss Edgell reviews the biological theories of Hering, Butler, Semon, and Jennings, the behaviourist theory of J. B. Watson, and Lloyd Morgan's variation of it; she gives a general outline of philosophical treatment of the problem from Hobbes to the present day, discusses the views of Alexander, Bertrand Russell and Holt, criticises Bergson, and finally offers what she terms a psychological conception of retentiveness. Although it is a brief account of sometimes elaborate theories, the book bears throughout the mark of long and earnest study of the problem.

Exercises and Problems in Practical Physics: with Notes on the Theory. By G. N. Pingriff. (Bell's Natural Science Series.) Pp. xxii+199. (London: G. Bell and Sons, Ltd., 1924.) 4*s.*

MOST of the practical work, with the exception of the most elementary, likely to be carried out in school physics laboratories is covered by this little volume. It is no mere compilation of recipes for securing "results," although of course adequate directions are given for performing the experiments, some of which are refreshingly original while evidently practicable and instructive. Most valuable, however, are the accompanying comments, suggestions, and queries, which are well calculated to arouse the interest of the student and encourage him to think for himself. There is in addition a good deal of useful information of a practical nature which is evidently the fruit of a wide experience in teaching physics. In short, the book may be confidently recommended to student and teacher alike.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Absorption Spectrum and Constitution of Sulphur Vapour. Predissociation of Molecules.

THE vapour of sulphur consists of a mixture of S_8, S_6 and S_2 molecules; the quantities present vary with the pressure and temperature (Preuner, *Zeit. Phys. Chem.* 68, 1910).

We have studied the ultra-violet absorption spectrum of sulphur vapour at temperatures between 100° and 1000° and pressures from 0·5 to 53 mm. The temperature of the vapour in an absorption tube of clear quartz, 50 mm. long, with plane parallel optically clear windows, was always higher than that of a communicating magazine containing sulphur. Thus the temperature of the latter determined the total pressure of the vapour, whereas the temperature of the absorption tube gave the partial pressures of S_8, S_6, S_2.

The spectrum was photographed with a Hilger E_1 spectrograph (system Littrow), the source of light being a condensed high frequency (10^6 p. sec.) spark between copper electrodes under water (Victor Henri, "Études de Photochemie," 1919, Proc. Roy. Soc. 105, 662, 1924). The spectrum of this source is continuous down to 2300 Å, except for a series of weak water-bands at 3064 Å. The measurements of the lines are exact to 0·02-0·1 Å, depending on the type.

The following principal results were obtained.

At temperatures and pressures, where only S_8 and S_6 molecules are present ($t<250°$, $p<10$ mm.), a general absorption without any structure is observed, beginning at about 2700 Å and increasing continuously up to 2300 Å (limit of our measurements).

By raising the temperature in the absorption tube, so that the partial pressure of S_2 attains about 0·05 mm., five sharp groups of bands appear with fine structure at 2798, 2829, 2861, 2892, 2927 Å, and three or four broad bands at 2768, 2739, 2713 and 2678 Å.

At higher pressures of S_2, the number of groups of bands increases towards the red and ultra-violet end. For example, at 550° and 0·55 mm., where only S_2 exists, there is no trace of general absorption, and the spectrum consists of 18 groups of bands from 3114 to 2592 Å. At 550° and 20 mm. (also S_2 alone) we obtain 26 groups, and at 750° and 53 mm. (still S_2 alone) more bands towards the red appear, the last one being at 3700 Å.

The intensity and the number of these bands are always determined by the partial pressure of the S_2 molecules; the presence of S_8 and S_6 produces only a general absorption at the ultra-violet end of the spectrum.

This spectrum of the S_2 molecules can be divided into three very distinct portions; they appear in exactly the same positions under all conditions.

First portion: from 3700 *to* 2794·2 Å. *Bands with fine structure—the rotational movement of the molecule is quantified.* In this portion we obtain 14 groups of bands between 2794·2 and 3300 Å with a constant frequency interval of $\Delta\frac{1}{\lambda}=397$ cm.$^{-1}$, and 9 groups from 2950 to 3700 Å with an interval of $\Delta\frac{1}{\lambda}=700$ cm.$^{-1}$. Each group of bands consists of 3-6 series of bands and each band of this series is made up of numerous sharp lines. In every band the lines are very sharp and near together $\left(\Delta\frac{1}{\lambda}=0{\cdot}1\text{ Å}\right)$, specially at the origin of the Q branch (ν_0) and at the head of the R (positive) branch, the distance between ν_0 and the head being 20·9 cm.$^{-1}$; the head is towards the ultra-violet. This means that the moment of rotation of the activated molecule, I_1, is greater than that of the normal molecule, I_0.

All these groups and series of bands with their fine structures overlap each other and the resulting aspect of the spectrum is very puzzling. In this portion of the spectrum there are more than 5000 fine absorption lines.

We have systematically studied the spectrum while slowly increasing the pressure of S_2. We were thus enabled to arrive at a successive development of it. The bands appear in a regular order and the fine structure of each band can be analysed. At the first appearance of a band its structure is absolutely classical, formed of three branches R, P, Q. At higher pressures the same band gets very complicated owing to the overlapping with the next one and by the appearance of other branches R′, P′, Q′.

By studying the bands at the lowest pressures at which they appear, we found that the lines could be distributed into three branches:

$$R(m):\nu=\nu_0+c_1(2m+1)+c_2m^2$$ positive branch $m\to m+1$

$$P(m):\nu=\nu_0-c_1(2m-1)+c_2m^2$$ negative ,, $m\to m-1$

$$Q(m):\nu=\nu_0+c_2m^2$$ zero ,, $m\to m$

with

$$c_1=\frac{h}{8\pi^2cI_1}=2\text{ cm.}^{-1},\quad c_2=\frac{h}{8\pi^2c}\left(\frac{1}{I_1}-\frac{1}{I_0}\right)=-0{\cdot}2\text{ cm.}^{-1}.$$

This gives for the moment of rotation of the normal molecule of S_2, $I_0=12{\cdot}6\times10^{-40}$, and for the activated one, $I_1=13{\cdot}8\times10^{-40}$. The distance between the nuclei of the two S atoms is therefore 0·7 Å in the normal and 0·73 Å in the activated molecule of S_2.

Second portion: from 2794·2 *to* 2592 Å. *Narrow continuous bands without fine structure.* Below 2794·4 Å the absorption spectrum of the S_2 molecules changes abruptly. The fine structure disappears entirely, the absorption spectrum consists of 8 groups of bands with a frequency interval between the groups of 360 cm.$^{-1}$. Each group consists of about 20 narrow bands having a width of 1 to 2 Å; these bands are absolutely continuous, containing no sharp lines. *This means the disappearance of the quantified rotation of the* S_2 *molecule,* and is a special case of a general result observed by one of us for many different molecules (Proc. Roy. Soc. 105, 662, 1924).

Third portion: from 2592 *to* 2475 Å. *Broad continuous bands.* At 2592 Å we observe a new change in the absorption spectrum. The narrow bands disappear abruptly and we obtain about 6 broad bands (width 15 Å) with an interval of 300 cm.$^{-1}$.

The analysis of the absorption spectrum shows two abrupt changes in the structure of the S_2 molecule: the first one at 2794·2 Å, corresponding to an increase in the internal energy of 102100 cal. p. gm. mol., thus causing a decrease of the frequency interval of oscillation of the two S atoms from 397 to 360 cm.$^{-1}$. This proves that the distance between the two S atoms in the S_2 molecule increases, which means that the bonds are weakened, the rotation of the molecule is *not* quantified. It is important to note that in this case, where the molecule absorbs rays < 2794 Å, its chemical activity is increased, as results from the interesting experiments of Norrish and Rideal, which we propose to follow in further detail.

The second change of the S_2 molecule at 2592 Å corresponds to an increase of the internal energy of 110000 cal. = 4·77 volts. It is very interesting to note that this limit corresponds exactly to the resonance potential of sulphur vapour 4·78 volts = 110400 cal. = 2582 Å (Foote and Mohler). This shows that by increasing the internal energy by 110000 cal. the valency electrons jump into higher orbits. The vibration frequency of the atoms is still more decreased (300 cm.$^{-1}$), the distance of the nuclei in the S_2 molecule is therefore still larger than in the foregoing case.

These interesting results obtained for the sulphur molecule lead us to a general discussion of different kinds of transformations of any given molecule. We know by the electronic impacts that at a certain minimum potential the impacts are no longer elastic; this occurs at the resonance potential of the molecule. It means that certain electrons jump from the normal orbit into the next one. But now we see that before this state is reached the molecule can be modified in its internal structure: the atoms are driven apart, the bonds are weakened, the molecule becomes more reactive, and the rotational movements are no longer quantified. This first modification is a preliminary preparation of the molecule for its total dissociation, and it is necessary to introduce a new term for this change. We propose to denote it by the term *predissociation* of the molecule.

For each molecule we can distinguish, therefore, the following successive states: *normal*, *predissociated*, *resonance*, *ionised*, and finally the *dissociation* of the molecule. In each of these states the molecule can be activated. By studying the absorption spectra of vapours we determine the limits of these different states of the molecules.

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Constant Differential Growth-ratios and their Significance.

A STUDY of the growth of the abdomen in the shore-crab *Carcinus maenas* (Huxley and Richards, unpublished) showed that whereas in the male the ratio *abdomen-breadth : carapace-breadth* remained constant, in the female it increased continuously during the whole of post-larval life.

Similar types of growth during the whole or part of life have been frequently recorded. Pézard (1918) has styled the growth of such an organ *heterogonic*, Champy (1924) *disharmonic*, as opposed to isogonic and harmonic respectively.

It seemed desirable to investigate this form of growth in a case where accurate weight-measurements were available: accordingly, advantage was taken of a visit to the United States to study the growth of the chelæ of Fiddler-crabs at the Marine Biological Laboratory, Wood's Hole. As is well known, the chelæ of females in these animals are small and equal throughout life, while those of males are unequal, one being similar to the female's, while the other is much enlarged. Morgan (1923 and 1924) has recently given us much information as to the time at and mode in which this asymmetry is determined.

The weights of whole animals of every size, and of their autotomised chelæ, were taken in *Uca* (*Gelasimus*) *pugnax*. The female and small male chelæ remain throughout life equal to ±2 per cent. of total weight.

For the large male chelæ, some 400 specimens were weighed, and divided into 25 classes by total weight. Let y = weight of large chela, w = total weight, $x = w - y$. It was then found that when $\log y$ was plotted against $\log x$, a remarkably straight line was obtained:—

$$\log y = k \log x + \log b,$$

where k and b are constants, $k > 1$, $b < 1$.

This was empirically established for total weights of 60 mgm. to more than 3.5 gm., and it can be deduced satisfactorily that it holds from the moment heterogonic chela-growth begins, which is at about 6-8 mgm. total weight.

The only complication lies in the fact that the slope of the line changes at a point corresponding to about 30 per cent. of maximum total weight, k here decreasing slightly to a new value, but remaining > 1. This change is probably coincident with sexual maturity, and would then be explicable through the gonad making a greater drain on the food-supply.

The simplest mathematical expression of the facts is $y = bx^k$. This implies that if during any given period, p is the fractional increase of x (total weight less chela), then that of the large chela in the same time is p^k. This would receive a biological explanation if the rate of cell-division were greater in the large chela than in the rest of the body throughout life, the two rates being as $k : 1$.

Since the *relative* growth-rates of organ and rest of body thus remain constant during long periods, I propose the term *Constant Differential Growth-ratio* for the phenomenon. Where the constancy of the ratio has not yet been ascertained, it is best to retain *heterogonic* as a more general term.

These facts have various corollaries: (1) The development of secondary sex-characters in Crustacea need stand in no relation with the gonad, or at least to maturity. (2) The male Fiddler-crab and the female Carcinus (and many other Crustacea) have *no definitive form*, their shape, as determined by the proportion of their parts, being a function of their absolute size. Thus even for purely morphological and systematic purposes, it will be needful to take measurements on large series of specimens, and to determine k in the above formula as one of the more important distinguishing marks of the species.

(3) Finally, we have the corollary, pointed out by Geoffrey Smith in 1905, that if this type of developmental mechanism holds throughout a group for any organ, the absolutely larger species of the group should possess this organ of relatively larger size than do the smaller. This relation has been shown to exist in Stag-beetles and many other Coleoptera, in Crustacea, and in Ungulata (G. Smith, 1905, Champy, 1924, etc.). It was tested out by us quantitatively on two species of Uca, with the following results:

	Uca pugnax.	*Uca minax.*
Maximum total weight	3·6 gm.	17·8 gm.
k, 1st period	1·61 – 1·64	?
k, 2nd period	1·32 – 1·35	1·58 – 1·66
Maximum ratio $y : x$, per cent.	65 per cent.	77 per cent.

Only a few *U. minax* were available, and those clearly all in the 2nd period.

It is interesting to find k near to 1·5 in all cases. If it were exactly 1·5, the surface of the chela would be increasing in direct proportion to the volume of the rest of the body. It remains to be seen whether this is a mere coincidence or not.

The greater absolute size attained by *U. minax* led to the largest large chela in this species attaining a

relative weight 12 per cent. greater than in the small *U. pugnax*. Our expectations are thus fulfilled.

This has an important bearing on evolutionary and genetic theory. If (1) a mechanism for the heterogonic development of any character occurs throughout a group, and (2) the evolution of the group has been on the whole from small to large size, we shall get apparent orthogenesis of the character. There is proof of (1) in the antlers of Cervidæ (Rörig, 1901, Champy, 1924), and strong probability of it for all horns and other bony excrescences in mammals. As regards (2), this size-increase has occurred in almost every group of mammals, and is probably to be accounted for by the biological advantage conferred (up to a certain limit) by increased size.

If so, then the apparent orthogenesis of horns, etc., in mammals, especially urged for Titanotheria by Osborn (1918, etc.), is no true orthogenesis at all, in the sense that it is not caused by determinate variation of the hereditary constitution. On the contrary, it would be automatically brought about by the increase of absolute size of the whole animal (which in its turn is probably effected by natural selection plus random variation, and not by determinate variation), together with the existence of the same type of developmental mechanism for horn-growth throughout the group. That is, orthogenesis would mean nothing else but directional evolution, and had better be dropped in favour of that term, because its past use has often implied directional evolution which is also determinate owing to internal causes.

Sturtevant (1924) has recently expressed somewhat similar ideas, but in a very general way, and without any numerical data. Champy (1924) has expressed still more similar views, but again without accurate measurements on large numbers of animals, which, in view of the degree of normal variability, are necessary to establish any quantitative law for the growth of heterogonic organs.

Full details will be published in due course. I have to thank Dr. Lillie for the hospitality of the laboratory at Wood's Hole, Mr. F. N. Ratcliffe for assistance in the work, and the Royal Society for a grant.

JULIAN S. HUXLEY.

New College, Oxford,
November 27.

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Theories of Growth and Senescence.

IN the thoughtful and stimulating criticism of my book, "The Chemical Basis of Growth and Senescence," which appeared under the above title in NATURE of August 23, there occur one or two statements in which my actual views are not correctly represented, due, no doubt, to inadequacy of expression upon my part. I desire to seize the opportunity created by the appearance of this criticism to express my views more clearly without entering into a detailed discussion of numerous other matters in which the reviewer and I chance, for the moment, to differ in opinion.

The reviewer states, "The evidence that the autocatalyst [of growth] is soluble and diffusible is based, not upon any evidence from the higher animals but solely on studies of infusoria, bacteria and yeasts." This is not quite the case even if we confine our attention to the evidence contained in the book and disregard that which, since its publication, has appeared elsewhere. It was inferred that the autocatalyst of growth must be soluble and diffusible in the higher animals, as well as in protozoa, for the following reasons :—(1) That Wildiers and others have found growth-accelerating agents in extracts prepared from a diversity of tissues, and these agents resemble in their properties (thermostability and solubilities) and behaviour (effects upon cell-multiplication) the accelerative agents which may similarly be extracted from yeasts and infusoria themselves. (2) That the fusion of the separate autocatalytic syntheses occurring in all the cells of the body into an autocatalysed curve representing the growth of the organism as a whole, could not possibly occur if all of the separate syntheses pursued their own independent paths. They must therefore be regulated by a product which is interchangeable between the various cells comprising the tissues of a higher organism. To be interchangeable between widely separated cells this product must to some extent, however slight, possess properties equivalent to solubility and diffusibility.

Since the publication of my book, however, this deduction has received direct experimental confirmation from two independent sources. A. Fischer (*Journ. of Experimental Medicine*, vol. 38, p. 667) has shown that contiguous fibroblasts in a circumscribed volume of culture medium mutually accelerate each other's multiplication, and M. T. Burrows has shown that the same phenomenon occurs in cultures of cancer-cells (*Southern Medical Journal*, April, 1924). The principle of allelocatalysis has thus been shown to apply to vertebrate tissue-cells no less than to cultures of yeasts or infusoria. In consequence of this effect the growth of the organism as a whole displays the time-relations of an autocatalysed reaction, nor does this interpretation of the curve of growth imply, as the reviewer supposes, that the syntheses which underlie and determine the rate of growth must necessarily occur in homogeneous solution, for, as Nernst has shown, reactions which occur at the surface of two immiscible phases may display the same time-relations as reactions which occur in homogeneous solution.

The reviewer very properly directs attention to the omission of any reference in my book to the important work of Dr. E. J. Allen on the growth of marine algæ (Jour. Marine Biol. Assoc., vol. 10, 1914, p. 417). My attention was directed to Dr. Allen's work, unfortunately too late to permit its inclusion in the book. Naturally, I would not advertently have omitted reference to experiments which afford such a remarkable illustration of the widespread occurrence and importance of growth-accelerating agents.

I do not regard regeneration as "an irreversible process of senescence," and am at a loss to understand how the reviewer could possibly have formed such an impression. I assert that lost parts tend to be replaced by a more (physiologically) differentiated type of tissue and that such growth of tissue must increase in some measure the senescence of the organism as a whole (that is, abbreviate its "expectation of life"). This, however, is very far from instituting an identification of regeneration and senescence. In regard to the nature of the stimulus which starts growth after injury, I have suggested that it may be in part the local increase of nutrient level. Obviously, the nutrient level in a circulating medium, such as blood, must be quickly equalised all over the body, but in the pericellular fluids, which really constitute the nutrient medium inhabited by the cells, such equalisation must be relatively slow. The nutrient level in these fluids at any particular point will therefore be determined, on one hand by

the rate of supply from the circulating medium, and on the other by the rate of local consumption. The latter factor must obviously be reduced by the removal of normally adjacent cells by injury.

I am surprised to learn that I have treated Child's theory of rejuvenescence and senescence "with silent contempt." This was very far indeed from my intention, for, on the contrary, I regard this theory as the necessary complement of my own. My presentation of Child's opinions may have been inadequate, but it was not intentionally so, and I must absolutely decline to view Prof. Child as an "opponent," even if for no better reason than because his demonstration of the existence of metabolic gradients in the tissues of the metazoa is one of the most important pieces of evidence upon which I base my interpretation of differentiation. To put the matter upon a crudely quantitative basis, however, the fifteen citations from Child's publications which my book contains should surely have sufficed to protect me from this accusation.

I am glad to avail myself of this opportunity to clear up an obscurity to which the reviewer directs attention in his final criticism. He credits me with the statement that "variation always takes place by loss of characters," and I must admit that my phraseology is open to this one-sided interpretation. My meaning, however, was this:—Since every new type of tissue which appears during development does so as a result of physiological differentiation, *i.e.* the omission from the new cells of certain nuclear constituents, it follows that the appearance of a character which depends upon the development of a new type of tissue must occur in consequence of a tendency of the germ-plasm to become deficient. Such a mutant, which undergoes more extended development and differentiation than that which occurred in the parent-type, must be recessive. Any mutation involving premature *arrest* of development and differentiation must, for the converse reason, be dominant. In my desire to make clear the first consequence of my hypothesis I omitted to elaborate adequately the second, which, indeed, appeared to me to be obviously implied in the first. Thus both dominant and recessive varieties may arise, but those which represent a positive gain of a new type of tissue cell must be recessive. Of course in any individual example, in the present state of our knowledge, it may be a very difficult matter indeed to decide whether a given external character is really attributable to the development of a new type of tissue or to the non-development of tissue-cells which occur in the parent-type, for, in general, the omission of any particular stage of differentiation must create opportunities for the development of other cells which would normally be denied to them.

If, however, devolution of the nucleo-cytoplasmic ratio ("physiological differentiation") can occur, it will, since this affords the only means by which the constituent cells of the organism can continue to propagate themselves, and the selection of lower nuclear ratios, to which the struggle for existence among the cells must lead, will ensure the appearance and multiplication of cells possessing lower nuclear ratios, if that is possible. Since "cellular selection" is always operating in a direction favourable to their appearance, new varieties which are recessive should, in the terms of this hypothesis, appear much more frequently than new varieties which are dominant, and the facts, as the reviewer himself admits, are absolutely in accordance with the theory.

T. BRAILSFORD ROBERTSON.
The Darling Laboratories of Physiology and Biochemistry, University of Adelaide,
October 5.

The Word "Scientist" or its Substitute.

IT will probably be agreed that language was made for man as a means of expressing his thoughts and feelings. It would seem to follow that the first duty of a word (or, to be precise, a noun) is to express an object or an idea definitely and uniquely. When this duty is fulfilled, the demands of philology and beauty might, and indeed should, be considered, but their importance is clearly secondary, except perhaps in poetry of a certain type.

It does not appear that any of the suggested alternatives to the word "scientist" fulfil this primary requirement. "Man of science" is anything but definite and unique. It might mean a Robot, or any of a large number of unintelligible things (cf. "men of stone," "man of sorrows," "men of Athens," "man of mark," etc.), the preposition "of" being perhaps the most indefinite word in the language. "Natural philosopher" is no better. It does not tell us whether it is the philosophy or the philosopher that is natural, nor does it distinguish between the various meanings of the word "natural," to say nothing of the word "philosopher." Nor is "rationalist" satisfactory. It includes, for example, both Galileo and his opponents, and totally fails to distinguish between the kinds of data on which they exercised their reason.

Sir Ray Lankester's suggestion, that "*we* must be content to be anatomists, zoologists," etc., does not seem to be practicable. If the collective word "science" is necessary, then, on precisely the same grounds, a collective word equivalent to "scientist" is necessary also. The fact that these collective words are necessary is exemplified by the front page of NATURE, where the paper is described as "A weekly illustrated Journal of Science"—not "A weekly illustrated Journal of Anatomy, Zoology, etc." Unless a collective word is used for the investigator, how, for example, is Dr. Jeans to be described? Are we to call him an astronomer-mathematician-physicist, placing the terms in alphabetical order to avoid suspicion of partiality and praying devoutly the while that he do not undertake psychical research?

It would appear that a word equivalent to "scientist" is necessary, and until one is suggested which expresses equally definitely and uniquely the idea implied, I cannot see any justification for rejecting "scientist" in the columns of NATURE or elsewhere. Since clear expression is so intimately bound up with clear thought, the question has more than an æsthetic interest.

HERBERT DINGLE.
Imperial College of Science and Technology,
South Kensington,
December 9.

MAY I offer some general observations in connexion with the question as to the use of the word "scientist."

Language appears to be our way of expressing ideas by posture and gesture of the tongue, lips, etc. These gestures are recognised by the musical effects produced when air is blown through the vocal cavities as they perform their symbolic movements.

The perfect language would be one in which all ideas were expressed by the simplest series of gestures, and in which each separate gesture or series of gestures always bore one and the same meaning.

Up to the present time, language has grown up without conscious human guidance; it is therefore full of inconsistencies, ambiguities, omissions, and redundances.

From this point of view, it would be well to review

our forms of speech wherever the present words appear to fail in their purpose.

"-ist" is a concise termination (my only objection to it would be that it contains the unvoiced hiss "s," and the unvoiced explosion "t," which are both inartistic and phonetically ineffective sounds). It is shorter than "-ian" (as in mechanician, etc.), and it already bears a different meaning from "-er" as in runner, singer, etc.

I would therefore plead not only for "scientist" as being a concise and expressive word for one who is skilled in science, but also would go further and suggest the more general use of the termination "-ist" to denote one who is an expert on the theory as well as the practice of the art which he practises.

Thus, we might have *chemicist* (and distinguish him from the "chemist and druggist," and *electrist* to run in parallel with "physicist." If "maths" has come to stay, "mathist" would be an obvious improvement on "mathematician."

There are good reasons why an art, so important to human welfare as language, *should* be rationally developed and improved for human use; it should not be compelled to remain for ever in the neolithic stage.

R. A. S. PAGET.

East India House,
74 Strand, London, W.C.2,
December 3.

YOU cannot help it; scientist is an established term, and you can no more suppress it than you can suppress bigamist. But if NATURE maintains its policy on the subject, I am sure we shall not grudge the Editor this little tyranny.

My belief is that objection comes almost entirely from the fact that the word scientist is cacophonous. If the word had been as well lubricated as its near neighbour "sciolist" I am convinced that we should never have heard any serious objection to it, unless perhaps Fate by some caprice had briefed Sir Ray Lankester for the prosecution.

There are already "Rationalists." I was taken to see one not long since, and I should like to be there when Sir Ray Lankester was seeing him. Natural philosophy is still physics in Scotland, and "naturalists" are everywhere students of natural history (sometimes nowadays confused with natural science). A real object of pity is the man who still has to indicate his calling to the public by styling himself

A CHEMIST.

Very Intense Magnetic Fields.

IN previous letters which appeared in the issues of NATURE for April 19 and September 20 respectively, I gave some details of a method for producing very intense magnetic fields.

I now give in Fig. 1 an oscillogram of the condenser current discharge through a solenoid wound with 25 turns per cm. length. The scale of this oscillogram is such that the second peak represents a current of 23,100 amperes in the solenoid winding. It follows, therefore, that the intensity of the magnetic field at the central part of the solenoid core was 730,000 gauss.

Apart from the very high value of the magnetic intensity thus obtained, an examination of the oscillogram of Fig. 1 yields some further very interesting results:

(i.) The frequency of the discharge current as given by the first half-wave of the current is very much higher than that of the rest of the wave. The frequency of the first half-wave about corresponds to the value as calculated from the static constants of the circuit.

(ii.) The current represented by the second peak is greater than that denoted by the first peak.

(iii.) The current values actually obtained are very much greater than those calculated from the constants of the circuit.

A full explanation of these effects is not yet clear. There is one factor, however, which has an important bearing on the phenomena, namely: The intense mechanical force developed between the neighbouring turns of the solenoid causes them to move relatively to each other, and in this way a back e.m.f.

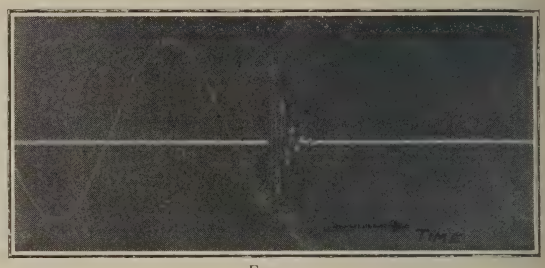

FIG. 1.

is induced in the solenoid winding which is equivalent to a change in the static constants of the circuit. The large wave shown in the oscillogram is a 50 frequency wave.

Magnetic fields of an intensity of 1,400,000 gauss have been obtained already by the method described, and there is definite evidence that the magnetisation curve of steel is changed after having been subjected to these very intense fields.

Further modification of the apparatus is now being effected by means of which it is expected that magnetic fields of an intensity of about 10,000,000 gauss will shortly be available.

T. F. WALL.

Edgar Allen Research Laboratory,
University of Sheffield,
November 29.

Chemical Reactions at High Pressures.

IT is generally recognised that under high pressures many chemical reactions which take place only slowly under ordinary conditions may be greatly accelerated, and new reactions, hitherto considered impossible, may reach a considerable velocity. This opens up a very interesting and important field of study, and there is little doubt that there may result many important industrial developments and even the creation of new industries. Before, however, the chemist can adequately discharge his functions in connexion with this work, it will be necessary for the engineer to provide him with the special tools which will be required in connexion with it. For example, new means will have to be found for the development and control of pressures of a much higher order than has hitherto been used. New methods for the handling of solids, liquids, and gases will have to be devised; heat interchange under new conditions will have to be studied. In fact, the technique of high pressure work generally will have to be developed.

May I suggest that, if Great Britain is to keep abreast of the advances which are being made in this field abroad, it is very necessary that the serious attention of our engineering schools and laboratories should be turned to the need of the chemist in this connexion.

WM. RINTOUL.

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Neanderthal Man and Grimaldi Man: their Rôle in the Evolution of Mankind.[1]

By Prof. RÉNÉ VERNEAU, Muséum national d'Histoire naturelle, Paris.

THE important discoveries in the domain of human palæontology which have been made in recent years, and those, far greater in number, which may be referred to the Neolithic period, have now made it possible for us to venture on an inquiry which seems to me not without interest. What, it may be asked, is the rôle that the nigritic element has played in the ethnology of the world in the past?

Wherever Neanderthal man occurs, he displays a remarkable homogeneity in character. It is no longer possible to regard him as physically or mentally diseased. He represents a primitive ethnic type which still retains a certain number of simian characters, as Schaafhausen and Huxley maintained, and as is acknowledged by all scientific workers of to-day who are free from prejudice. It is also incontrovertible, in my opinion, that Neanderthal man, taking his characters as a whole, can be brought into relation only with the nigritic group—a point which, I hold, it should not be difficult to demonstrate. But what is the rôle that he has played, and how great is its importance in the evolution of mankind? This is a point upon which there is complete disagreement among men of science. It is a question which appears to me to be sufficiently interesting to be discussed in some detail.

When it is admitted with Huxley, de Quatrefages, and Hamy, to mention a few only of those who have held this view, that there still exist in Australia representatives of the Neanderthal type who, however, in the course of ages, have undergone certain modifications under the influence of environment, the answer is simple. This type must have played a part of some note, since it has been able to perpetuate itself to this day in a country in which, as all agree, the environment has remained relatively stable. In Europe, so far as our present knowledge goes, the evidence for its existence is more difficult to follow. At the same time, de Quatrefages and Hamy held that certain characters observed in Neolithic crania and even in modern crania were atavistic manifestations of an ancestral state. On this view Neanderthal man should be regarded as one of our ancestors.

This theory, which is accepted by a number of anthropologists including myself, has been violently opposed by those who are unable to bring themselves to include in our ancestry a type which retained simian characters.

To-day, a whole school, which includes a number of eminent workers to whose knowledge and sincerity I render the fullest homage, and who for the most part call themselves evolutionists, maintains that Neanderthal man has bequeathed no single drop of his blood to modern man, and that *Homo Neanderthalensis* is a distinct species which has been replaced by *Homo sapiens*. To dispute a theory which is in the fashion is always an ungrateful task, especially when one appreciates the great merit of one's antagonists. Nevertheless, I may perhaps be permitted to set out the arguments of those who uphold these new ideas and the reasons which forbid me to agree.

[1] Translated from the Huxley Memorial Lecture for 1924 of the Royal Anthropological Institute, delivered on November 25.

The palæontologists, relying for their argument upon the extinction of various species of animals during the geological ages, maintain that man is no exception to the general rule. I agree without the slightest qualification that human beings are subject to the great laws which govern other forms of organic life. But we must discover which of these laws is responsible for the disappearance of those species which have become extinct. To me there can be no doubt that that law is the adaptation of the organism to the environment. When the environment undergoes profound modification, as was the case in past geological ages, the organism, being no longer in harmony with the new conditions of existence, which it is unable to modify and to which it cannot adapt itself, must perforce disappear. In the case of man, however, the facts must be looked at from a different point of view. Although it is true that from the beginning of the Quaternary, that is to say from that point of time from which we can follow up man with certainty, changes in the environment have taken place, they have not been so considerable as to make it impossible for man to adapt his organism to the new conditions. There is proof of this in the remains of man's handiwork which are found at every level. There is another consideration which is not taken into account: the emigration or extinction of the Pleistocene species, whether they belonged to the warm or the cold fauna, takes place in close relation to climatic conditions, against which man, even of the most primitive type, is able to struggle in virtue of his intellectual powers. It follows then that while man is to a certain degree subject to the influence of his environment, he is able through progressive adaptation to evade the violent shock which brings about the disappearance of other species.

Among those who receive new ideas with their eyes closed and attach more importance to words than to facts, there are some who may object—and this has actually happened to myself—that it is not proved that Neanderthal man was an intelligent being. Their doubts are raised by the nomenclature applied to primitive man—or, at least, to one of his branches, now said to be extinct—and to modern man, who is known as *Homo sapiens*. The term *sapiens* is quite inappropriate, as it is applicable only to moral or intellectual qualities, and there is no specific reason for applying it to *Homo sapiens* to the exclusion of *Homo Neanderthalensis*. As regards the moral qualities of the latter we can only advance pure hypotheses; but it is quite another matter in regard to his intelligence. Here I may leave the argument to one of the most eminent and at the same time one of the most firmly convinced upholders of the theory that *Neanderthalensis* became extinct at an early date, my learned colleague and friend, Prof. M. Boule. After having stated in his great work "Les Hommes fossiles" that certain backward peoples of the present day, whom nevertheless he classifies as *Homo sapiens*, are to be brought into relation with Neanderthal man, "if not from the point of view of physical characters, at least from the point of view of moral qualities" and by their mode of life, he adds, "the latter is already man, notwithstanding

the morphological inferiority of his brain, and is in no way the precursor of man, since we find mingled with his bones the implements of stone that he knew how to make and the ashes of the fires he knew how to light and how to tend. Already his actions are those of modern savages; and if naturalists, abandoning their usual practice, were to base their classification of the beings they study upon intellectual qualities, they would have no specific ground for a separate classification of Neanderthal man and modern man; while, as we have already seen, it would not be possible to refuse him this distinction on the ground of his physical characters."

That is how the question stands. *Homo sapiens* is not marked off from *Homo Neanderthalensis* by his intellectual qualities, as we might be led to suppose from the specific title which has been bestowed upon him. It is by his physical characters that he is separated from modern man, even in the case of peoples of the most primitive type. This is well shown by an examination of the cranial characters of Neanderthal man and comparison with modern types such as Australian, Bushman, etc.

From what has been said, it emerges that there is no character which has been observed in *Homo Neanderthalensis* which is not to be found in modern man, though principally among the nigritic races. But, as Prof. Boule has very rightly said, it is not the existence of an isolated character which is of interest to us from this point of view. "It is the presence, the conjunction, the accumulation of these characters in *each* of a whole series of crania" which has value. Each skull in the Australian series of this type with which I have dealt presents such an accumulation of characters of the Neanderthal race that it is impossible for me not to accept a close relationship between the two groups. To my mind, the Neanderthaloid Australian skulls prove that the Neanderthal race has not "died out without leaving any descendants." It follows that this nigritic race, which played an important part in antiquity, has also made its influence felt in man of to-day.

But if the Neanderthal type [Rhodesian man] persisted in Africa, why could he not have persisted in Australia, and why should he not have submitted there to the influence of environment as he did in Rhodesia? Could he not have been modified as Rhodesian man was in some degree when he acquired the upright attitude? When we consider the enormous distance in space and time which separates the Neanderthaloid Australians from our Mousterians, it is difficult to conceive that the type could have perpetuated itself in New Holland without modification. This would be a denial of the influence of environment which I could not accept.

On the other hand, it may be argued that, judging by its flora and archaic fauna, the Australian environment does not appear to have undergone any great change. It is this which explains precisely how it is that the characters of the southern tribes have only suffered some attenuation. To maintain that the conditions of existence of these natives have remained absolutely stable, and to hold that the Australians have not progressed, is an untenable hypothesis. The main characteristics of the material culture of the Australians show that this is not the case. All this denotes that, however backward they may be, the Australians have evolved and they no longer stand where stood the Mousterians in Europe. It would not be credible that while their intelligence developed their physical characters remained immutable. But their evolution has been very slow and they have preserved a group of Neanderthal characters sufficiently well-marked to lead me to regard them, as Prof. Boule has done elsewhere, as derived from the same source as *Homo Neanderthalensis*. These characters are beyond question nigritic, and it is difficult to refuse to admit that this nigritic element, which played a part in Europe in the first part of the Quaternary age, has not bequeathed its blood to modern man, notably the South Australian and apparently in a lesser degree to other Melanesians.

Let us now see if traces of it can still be found in Europe at the present day. There have been found on many occasions in prehistoric, historic, and modern burials, skulls which reproduce in part the characters of the ancient fossil race of which we are speaking. There are specimens in many museums and since 1882 the authors of "Crania Ethnica" have described a number of examples. Additions are being made to these observations continually. In 1914, for example, Verworn recorded two skeletons found at Obercassel, near Bonn, in a hearth of the Reindeer age. He noted that they presented certain resemblances to the races of Cro-Magnon and Chancelade, and, in addition, showed Neanderthal characters. Beside this nigritic bestial type there is another, more highly developed, representatives of which are to be found dating from the Quaternary epoch. This is the negro type which I have called the race of Grimaldi, as the first examples were found near the Italian frontier in the territory of a commune bearing this name. The physical characters of Grimaldi man show close resemblances to the negro type.

In the presence of so many characters which are frankly nigritic, and of which some indeed recall those of *Homo Neanderthalensis*, it must be recognised that, at one point in the Quaternary period, negroid individuals lived in Europe. It may, however, be asked whether the two subjects from Baoussé Roussé were not negroes who arrived there accidentally and disappeared without exercising any influence in Europe. My researches on this problem have led me to discover in several museums in Southern Italy modern crania with characters which incontestably recall those of the Grimaldi race. I have even found two living subjects who came from the Graian Alps, where it is difficult to believe that any negro could have penetrated in recent times; these showed a number of the cephalic characters of the Baoussé Roussé negroids. When once attention was directed to this point observations multiplied. Skeletal remains of negroids have been found in collections from France, Switzerland, Italy, and North Africa. Some dated from the Upper Palæolithic (a series of crania from the rock shelters of La Mouillah on the frontier of Western Algeria), others from the shell heaps of Tebessa, of which the age is disputed, and others from the Lower Neolithic of the Province of Oran. In North Africa, the negroid element must have formed the ethnic substratum of the whole of the Berber country. In Europe we find it in the Neolithic age in Brittany, in Switzerland, in Illyria, the Balkans, etc.; in the Bronze and early Iron ages in

Switzerland, in Southern Italy, and so on. It is plausible to attribute to atavism the prognathism, often very pronounced, and the retreating chin which is to be observed to-day among certain individuals who do not otherwise exhibit nigritic characteristics, either in the hair or in the coloration of the skin. As I wrote in 1906, "since we still find to-day so many traces of an ethnic type with characters which recall those which I have observed in the Grimaldi race, we are compelled to believe that this race was formerly represented among us by a whole group." I might add, however, that the same type must have been equally strongly represented in North Africa.

To sum up, the division of mankind into two entirely distinct species, *Homo Neanderthalensis* and *Homo sapiens*, the first long extinct and leaving no trace behind, does not appear to me to be justified. The Neanderthaloid characters of the Australians indicate a close relationship with our Mousterian man, while on the other hand, certain features in Neolithic or modern skulls found in Europe are to be explained as due to atavism. The race of Neanderthal, thoroughly nigritic in type, has continued to play its part among us, as it has in Africa, Australia, and elsewhere. Observations made on the Pleistocene skeletons of Wadjak and on remains from the mounds of Nebraska lead me to believe that the same element has entered into the ethnology of Java and the New World.

In the case of Grimaldi man, no doubt is possible. The traces can be followed in Europe almost step by step from Aurignacian times to our own day. In North Africa its existence is equally apparent though it may not be possible to fix the date of its appearance with precision. Another nigritic element, the Papuan, has just been noted in Tonkin by M. Mansuy on sites which take us back to a Neolithic period of very high antiquity. In 1879, A. de Quatrefages observed similar characters in a fossil cranium from a cave near Lagoa Santa in Brazil. P. Rivet has found the type represented in some abundance in the rock-shelters of Paltacalo in Ecuador; and it appears among the Pericues, an extinct tribe of Lower California, which H. ten Kate had already recognised to be clearly related to the Melanesians. I myself have pointed out the existence of this strongly marked type among the Tunebos of Colombia. From California to the extreme south of America the nigritic element has played a part of sufficient importance to leave its traces everywhere.

From all these facts I conclude that mankind in the beginning was represented by one or more nigritic types of marked bestiality and retaining several simian characteristics. These primitive elements have evolved and have given rise to the great negro stocks of to-day, the African and the Melanesian. This evolution has been progressive. We have a proof, in my opinion, in the intermediate types found at Talgai and Wadjak. These intermediate types, while evolving in some degree, have perpetuated themselves to the present day in special conditions, as, for example, among the non-Neanderthaloid Australians and the New Caledonians. Our Grimaldi negroids are too far removed from Neanderthal man to allow us to suppose that they are immediately descended from him, especially if the interval separating them is relatively small. Where could this type have become established? I do not know. On *a priori* grounds we think of North Africa; but the negroids of North Africa appear to be more recent than those of Baoussé-Roussé.

The conclusions which emerge may be summed up in a few lines:

(1) Primitive man exhibited simian characters pointing to relationship with the anthropoids. This archaic type has not become extinct; it has evolved in accordance with its environment. Traces of it occur very sparsely in Europe, but are readily discernible in South Australia.

(2) This primitive type was followed by a more developed type in which the simian characters have gradually disappeared, but in which the nigritic characters are retained in a marked degree. Although it plays only a very insignificant part among ourselves, this is not the case in other parts of the world.

(3) Recent discoveries lead us to suppose that a nigritic element has everywhere preceded the yellow and white races.

In truth, there are too many gaps in our knowledge for it to be possible to follow step by step the evolution of man in time and space. The links which are needed to establish the filiation of the races are missing. Yet it seems to me that my view of the question is more nearly in accord with the facts than that which accepts a gap between early man and man of to-day.

The Biological Action of Light.

THE beneficial action of a change of climate, especially when a sunny place is chosen, is well known: why the change is so frequently more effective than other therapeutic methods is a question which has only recently been investigated scientifically—one of the many examples of the lag in the acquirement of scientific knowledge behind popular opinion. Apart from the mental effects of a change of scene, benefit may be derived from both the cooling power of the air and also the incidence upon the body of the sun's rays. C. Lee Pattison (*Lancet*, October 18, 1924) has recently given an account of the therapeutical effects of ultra-violet radiations, while C. Dorno (*Naturwissenschaftliche Umschau d. Chem. Zeitung*, October 1924) has considered the subject more from the physical aspect. The effects of the different parts of the spectrum are not the same, the ultra-violet rays being the most active therapeutically. They are present in the atmosphere to a much greater amount, relatively to the infra-red heat rays, in summer as compared to winter, but their activity is confined to the superficial layers of the skin, since they have only a low penetrating power. It must be remembered also that these rays are largely absorbed by glass, and therefore exposure must be made in the open air or directly to a source of ultra-violet light.

It appears possible that rays of a shorter wave-length than 290 $\mu\mu$, which do not occur in the solar radiation, may be still more effective than the latter. The skin pigment absorbs chiefly the visible yellow and green rays, with the production of heat, which is then radiated outwards by the skin, while the red and short

infra-red penetrate still more deeply. In this way, in a cold atmosphere, the body temperature is higher in the deeper parts but falls, from radiation from the skin, towards the surface. If this radiation from the skin is mostly prevented, as in a warm damp tropical atmosphere, the surface of the body tends to have a higher temperature than the deeper portions : hence arises the enervating influence of the tropics, whilst in a colder (and sunny) climate the conditions are invigorating.

The increased loss of heat from the skin in a cool atmosphere, as at a high altitude, appears to be greater than the increase in the temperature from the absorption of light and heat rays, since, as Leonard Hill has shown, the metabolism of the body at rest is increased from 50 to 100 per cent. under these conditions, and to this increase is due a great deal of the benefit which ensues. Further, a cool atmosphere is usually drier than a warm one, and this promotes an increase in the evaporation of aqueous vapour from the lungs, with a resultant increase in the flow of fluid through the respiratory membranes, thus aiding in the healing of any lesions of the respiratory system which may be present.

Apart from alterations in metabolism and temperature, various changes in the constitution of the body under the influence of light have been described. Thus, there is an increase in the bactericidal power of the blood : whilst the formation of the blood platelets has been found to be stimulated (Cramer and Drew). The now well-known beneficial effect of sunlight in rickets appears to be due to a mobilisation of any vitamin A which is still in the body, without, however, causing its synthesis : light, therefore, enables normal growth to continue on diets which are relatively deficient in vitamin A. The body changes in rickets depend on a disturbance in the metabolism of calcium and phosphorus and are accompanied by a reduction in the amount of inorganic phosphorus in the blood. The addition of vitamin A to the food or exposure to light, especially ultra-violet rays, produces an increase in the blood phosphorus together with increased retention of this element and calcium (Orr, *et al.*). It must, however, be remembered that light, like other therapeutic agents, should be used with caution, since in certain cases it may produce a depressing effect, impairing, instead of strengthening, the body's resistance.

Obituary.

Prof. J. I. Hunter.

BY the sudden death of Dr. John Irvine Hunter, Challis professor of anatomy in the University of Sydney, while on a visit to England, British anatomy has lost its youngest and most promising recruit. In our issue of December 6, p. 842, it was stated that a course of free public lectures on "The Anatomy and Physiology of the Sympathetic Innervation of the Striated Muscle" would be given at University College at five o'clock on December 8, 10, and 12, by Prof. Hunter. On Monday, December 8, when an audience assembled, it was Prof. Elliot Smith's painful duty to announce that Prof. Hunter had fallen ill on Saturday and was then lying in University College Hospital. Typhoid fever was diagnosed, from which he had evidently suffered for some time before giving in. On Wednesday, December 10, the date on which his second lecture was due, he sank and died from heart failure at the early age of twenty-seven, having occupied his chair for only three brief but brilliant years, leaving a young widow and a wide circle of friends in England and Australia to mourn the loss which had so suddenly and so unexpectedly overtaken them. He was buried in North Finchley cemetery on Friday, December 12, after a brief but impressive service in St. Pancras church.

It is given to few men to be elected to a senior chair in their twenty-third year and in four short years to establish a reputation which places them amongst the leaders of their chosen profession. When we seek to discover how success came to Prof. Hunter so early and so rapidly, we recognise that credit must be given to his master—Prof. J. T. Wilson. On relinquishing the Challis chair of anatomy in the University of Sydney on his appointment to the chair of anatomy in the University of Cambridge in 1920, Prof. Wilson urged the appointment of Dr. Hunter as his successor—although the latter had only just completed his medical studies. Dr. Hunter was duly appointed and given a year's leave to study in Europe, spending most of this period with Prof. Elliot Smith at University College, London.

In his later years in Sydney, Prof. Wilson was keenly nterested in the nerve supply of voluntary muscles and impressed upon his pupils the importance of discoveries made in Holland by Boeke, de Boer and Langelaan—namely, that voluntary muscles have a double supply of motor nerve fibres ; they receive not only the myelinated fibres from the somatic system but also non-myelinated from the sympathetic system. It was the functional significance of this double nerve supply which Prof. Hunter made his own subject. He set himself to master the wide and intricate literature of his chosen subject and found guidance and inspiration in the researches of Sir Charles Sherrington. The theory which he formulated and sought to prove was that all kinds of muscle, both voluntary and involuntary, have a double nerve supply because they have a double function. A muscle must have the power of assuming a new form ; it must also have the power of maintaining the new form thus assumed. Prof. Hunter's theory is that the somatic or myelinated nerves have to do with the first power ; the sympathetic or non-myelinated with the second.

On his return to Sydney, Prof. Hunter found that another pupil of Prof. Wilson—Dr. Norman D. Royle—was also interested in the same problem but from a different point of view. Dr. Royle wished to relieve those soldiers who, as a result of wounds of the brain, suffered from the condition known as spastic paralysis—a condition of muscular spasm which renders easy movement of the limbs an impossibility. Prof. Hunter and Dr. Royle proceeded, after a preliminary series of experiments on animals, to treat these maimed soldiers on the assumption that the spastic condition of the muscles must be due to the action of their sympathetic nerves. Dr. Royle operated and cut off the sympathetic supply, with the result that the spastic condition disappeared and the patients gained an improved control of their limbs.

By the summer of 1923, Dr. Royle had treated some sixty cases with varying degrees of success, while Prof. Hunter had carried out a series of new experiments to elucidate the share taken by sympathetic nerves in regulating muscular action. A sentence from an address which Prof. Hunter gave at this time to an association of Australian medical men illustrates his native modesty and his methods of investigation. "It is the purpose of this address," he said, "to show how this work enables us to correlate for the first time with a sufficient measure of confidence two lines of anatomical and physiological research which have been pursued in various laboratories throughout the world and chiefly have remained as independent observations." Prof. Hunter claimed to play the part of a mere "honest broker" in science. He was doing much more than this. His constructive brain was busily fitting into place the disjointed fragments of an eminently workable hypothesis; and he knew how to devise experiments to elicit evidence.

When these researches were well under way, Australia was visited by the two eminent American surgeons—the Mayo brothers. They were so impressed by what they saw in Prof. Hunter's laboratory and Dr. Royle's wards in Sydney that on their return to the United States they urged the College of Surgeons of New York to invite the Sydney workers to give the Murphy Oration—the highest honour in its gift. The invitation was given and accepted, and in October last Prof. Hunter gave the Oration in New York. This over, he hastened to England to revisit his friends, bringing with him his recently wedded wife. He visited Cambridge and lectured there and then returned to London to lay his discoveries before his old colleagues at University College, when there followed swiftly and unexpectedly the fatal event which has just been told.

Prof. Hunter's investigations were by no means confined to nerves and muscles; he was an anatomist in the widest sense. He was a student of human races, and in co-operation with Prof. Elliot Smith produced a new reconstruction of the Piltdown skull and assisted in the interpretation of the brain of Rhodesian man.

The students of the University of Sydney lose a born teacher and a leader who had gained a place in their hearts. Nor is it too much to say that British science has lost a recruit who carried a marshal's baton in his knapsack. We should convey a totally wrong impression of John Irvine Hunter if we lay stress merely on his power of application, his scholarship, his gift of easily disentangling evidence and of recognising "key" facts, and his mastery of technique. He felt the joyousness of youth and life; he entered into all the pursuits of ordinary men with zest; his interests were wide and he carried himself with a modesty which was natural as it was sincere. In recent years death has robbed science of some of its youngest and most promising votaries but in few cases is there entwined so deep a sense of loss and of tragedy as clings round the death of young Prof. John Irvine Hunter.

DR. C. F. NEWCOMBE.

DR. C. F. NEWCOMBE, whose death on October 19 is just reported from British Columbia, went out to that country about thirty-five years ago from the English Lakes. The lovely coast of the north-east Pacific inspired in him a passionate devotion. With scarcely any scientific companionship, he followed with wonderful singleness of heart the pursuit of knowledge through the rest of his life. He was the moving spirit in the Natural History Society of Victoria, which did much, in the short period of its activity, to reveal, by dredging, the almost incredible riches of the Strait of Juan de Fuca. He himself worked out extensive collections of mollusca and crustacea from this and many other localities.

At the same time Newcombe acquired an exact knowledge of the flora of the coast and made valuable palæontological collections from many parts, but he will always be remembered for his wide and intimate acquaintance with the Indian tribes, especially the Haidas of the Queen Charlotte Islands, whom he regarded with a deep but discerning affection. He made countless journeys from Victoria northwards, often in an undecked motor-boat, and taking great risks. On the last of these he took the chill which caused his death.

Quite early in his work Newcombe marked out a policy from which he never deviated. The decay of the culture and handicrafts of the gifted peoples of the coast could not, he felt, be arrested. The best that could be done for the benefit of posterity was to see that these should be adequately represented in museums by such memorials as their totem-poles, their boats and their carvings. The museums of the United States were not slow to profit by his disinterested efforts. Very many totem-poles, obtained by him only after settling difficult and complicated claims, and snatched, in some cases, from destruction at the hands of their owners, are now the most impressive objects in great anthropological collections. For his trouble he never claimed more than out-of-pocket expenses. Latterly he succeeded in kindling a local interest in these riches, and the museum at Victoria contains many important accessions obtained by him, as does the National Collection at Ottawa. It was a genuine source of regret to him that the Canadian and British Governments and scientific authorities were not sufficiently alive to the importance of these native relics, for he would have vastly preferred to enrich the museums of his own country.

Newcombe never published any accounts of his experiences and observations amongst the coast Indians. No one who had ever talked to him for long could doubt how valuable such accounts would have been. His diffidence and high critical sense dissuaded him, however, from premature publication, and in 1911 the early failure of his eyesight made prolonged writing impossible.

In 1913 Newcombe was placed in charge of a commission to report on the sea-lions of British Columbia and their relations to the fisheries of the Dominion, the report of which embodies his experience through many seasons. It shows his characteristic respect for careful observation and his disinclination to arrive at conclusions except on the strongest evidence, and is a valuable account of the natural history of the animal and its place in native life. Nor can we close this notice without mentioning his intense interest in and laborious research into the records of the discovery of British Columbia. In 1914 the Provincial Government published as a memoir his account of "The First Circumnavigation of Vancouver Island."

To those who enjoyed Newcombe's friendship it cannot but be regretted that such a many-sided, humorous and charming personality has been lost to us without leaving an adequate memorial, and to those who are interested scientifically in the Pacific coast of Canada, the closing of so rich a storehouse of knowledge of a dying race is an unparalleled disaster.

Dr. John Beard.

We regret to record the death of Dr. John Beard, who was lecturer in embryology and in comparative anatomy of vertebrates in the University of Edinburgh from 1890 until 1920. Beard was born in 1858 and received his early scientific training in the Owens College, Manchester, and in the Royal College of Science, London, where he studied under Huxley. He also spent periods of study in the Universities of Würzburg and Freiburg, and became thoroughly conversant with the German literature of zoology—especially in embryology—as well as with that of British and other workers. On his return to Great Britain he was for a time in the service of the Scottish Fishery Board as naturalist at the Marine Laboratory at Dunbar, and it was from this post that he was invited to succeed the late George Brook as lecturer in embryology in the University of Edinburgh. He was soon afterwards appointed also lecturer in comparative anatomy of vertebrates, and he was for some twenty years or more senior assistant to the professor of natural history, Prof. J. C. Ewart.

Beard was most at home in his course of embryology, and in his best years, before his health began to fail, he was a stimulating teacher, one who aroused the true spirit of investigation in his pupils, and of his published work the most enduring is likely to be that which deals with certain features—the nervous system, the thymus, the germ-cells—in the development of elasmobranch fishes. About seventeen years ago he reached the conclusion, largely on embryological grounds, that tumours, benign and malignant, should be treated by means of pancreatic ferments, and the remaining years of his working life were chiefly devoted to the discussion of this question. It eclipsed his interest in his earlier lines of work, but his co-workers in zoology always continued to hope, until his breakdown, that his profound knowledge of the details of development of elasmobranchs, and especially of the skate (Raja), would be made available by publication to future workers.

Beard had a keen mind and was a forceful writer. He had great skill in zoological technique and he formed a large collection of microscopical preparations—chiefly complete series of sections—for the study of the development of Raja. In his later years at the University he was not in good health, and a breakdown in 1920 brought about his retirement from the staff. During recent months his health had distinctly improved, but on November 22 he had a stroke and died in Edinburgh on December 2.

Mr. J. A. Wheldon.

An active and accomplished botanist passed away on November 28, at Aintree, Liverpool, in the person of Mr. J. A. Wheldon. James Alfred Wheldon was born at Northallerton in 1862, and was educated at Cleveland College, Darlington, and the Westminster College of Pharmacy. He qualified as a pharmacist about 1884 and started in business at York, but four years later a disastrous fire robbed him of all his collections. In 1891 he was appointed pharmacist at H.M. Prison, at Walton, Liverpool, a post which he held for thirty years. Until he received this appointment, Mr. Wheldon's botanical studies were chiefly concerned with phanerogams, but from this point he devoted much of his time to mosses. He was one of the founders of the Moss Exchange Club, which afterwards became the British Bryological Society, and during its latest season distributed nearly 5000 specimens, for which Mr. Wheldon acted as referee. In 1907 he published his most extensive botanical work, the excellent "Flora of West Lancashire," in conjunction with Mr. Albert Wilson, but his pen was constantly busy, especially on mosses. In 1901 Mr. Wheldon was elected a fellow of the Linnean Society of London, and withdrew in 1918 upon his retirement; but last year he was elected an associate of the Society, a distinction he greatly valued. He received the honorary degree of M.Sc. from the University of Liverpool in 1922. His botanic collections were extensive and embraced practically every group of cryptogams; they would be a worthy accession to some institution.

B. D. J.

Prof. Franz Schrader.

The death of M. Franz Schrader, formerly of the Ecole d'Anthropologie of Paris, which occurred in October, removes one of the most eminent of French geographers. Born at Bordeaux in 1844, Schrader travelled widely in Europe in his youth and served in the Franco-German war. By the influence of Elisée Reclus he turned to geography, his interests lying in the human rather than the physical aspect. But it is for his cartographical work that Schrader was best known. He completed and published in 1893 the "Atlas Universal de Géographie" begun by Vivien and Saint-Martin many years earlier. The last edition of this atlas was published in 1922 and is the principal French atlas of the time. Other notable works of Schrader were "Atlas de Géographie moderne" (1890) and "Atlas de Géographie historique" (1896). He was the editor of the annual publication entitled "L'Année cartographique," which records all new publications in cartography and exploration. As a keen alpinist, Schrader found much interest in devising his tacheograph by the use of which he produced his "Carte des Pyrénées centrales."

We regret to announce the following deaths:

Dr. J. F. W. Tatham, formerly Superintendent of Statistics at the General Register Office, on November 8, aged eighty.

Dr. T. L. Watson, Corcoran professor of geology at the University of Virginia and director of the Geological Survey of Virginia, who was known for his contributions to mineralogy, petrology, and economic geology, on November 10, aged fifty-three.

Current Topics and Events.

IT is a pleasure to record that Sir James Mackenzie, honorary physician to the King in Scotland, has been awarded the Charles Mickle Prize offered by the University of Toronto for the best work to advance sound knowledge of a practical kind in medical art or science during the last ten years. Sir James Mackenzie is a typical Scot, possessing in a remarkable degree the qualities which have made Scotland famous the world over. These qualities, native ability, imagination, conscientiousness, and dogged perseverance, have raised him from the rank of an ordinary general practitioner of medicine to a high position as an investigator and pioneer in connexion particularly with diseases of the heart. Although there was a very considerable mass of knowledge on the heart long before his time, Sir James had the merit to approach the subject in his own original and thinking fashion, and by following up the histories of his patients in a personal and kindly way he amassed a great amount of knowledge of the fate of patients with cardiac disease, and was able to write on the subject with first-hand knowledge.

LONG a practitioner in Burnley, it was here that Sir James Mackenzie wrote his remarkable work on the pulse and appreciated more than any one of his time that the only real test for a heart is its capacity to deal with the daily work which it has to do. In the course of his work he investigated the irregularities of the heart, classified them on a sound physiological basis, and studied their prognostic significance and their rational treatment. This, we think, is the work by which he will best be remembered. Associating himself with physiologists like Hill, Keith, Flack, Cushny, MacWilliam, and Lewis, he was also largely instrumental in applying physiological work to the needs of practical medicine, and he founded the new branch of cardiology. The later work in which he tried to elucidate the early symptoms of disease by ordinary methods of clinical observation does not appear to have been so successful. Not the least of his merits has been the encouragement which he gave to a band of young workers who have done admirable work in filling up the lacunæ in the cardiological fabric.

ALTHOUGH the valuable material obtained by officers of the Indian Archæological Department on the sites at Mohenjo Daro and Harrappa in the Indus Valley referred to in NATURE of October 18, p. 584, and October 25, p. 623, will need to be supplemented by further investigation, it now appears to be generally agreed that these discoveries have nearly doubled the period covered by our knowledge of Indian antiquities, taking it back to at least 2500 B.C. It is also clear that the finds belong to a widespread culture which must have flourished for many centuries. The peoples of Sind and the Punjab were then already living in well-built cities and were in possession of a mature civilisation. According to a report from Sir John Marshall, quoted in the *Times* of December 10, a careful examination and comparison of the antiquities found leaves no doubt that they are closely connected with, and approximately contemporary with, Sumerian antiquities from Southern Mesopotamia which date from the third or even the fourth millennium B.C. The origin of the Sumerians is obscure, but it is held by many that they were entirely distinct, both linguistically and otherwise, from other races in Mesopotamia, and were an intrusive element from the outside, possibly originating to the east in India. Sir John Marshall, therefore, regards it as a reasonable hypothesis that India was the cradle of the Sumerian civilisation which lay at the root of the Babylonian, Assyrian, and Western Asiatic cultures generally. It is highly desirable that the exploration of Indian sites on an extended scale should be pushed on with as little delay as possible, especially with the view of the elucidation of the pictographic script, which appears to be so closely related to the Sumerian system.

DURING the transcontinental excursion of the British Association and the International Mathematical Congress, after the meetings in Toronto in August last, Sir Richard Paget designed an amusing totem pole representing the various sections of the Association. A reproduction of this drawing, in colour, has been prepared, and will be obtainable from the secretary of the British Association, Burlington House, London, W.1, price 2*s.* (postage 1½*d.*). By Sir Richard Paget's permission the drawing is here reproduced, in black-and-white, reduced by one-third linear dimensions. At the top of the pole is the head of the British Ass. with balancing scales in its teeth. Below it are symbols of the thirteen sections in descending order, namely, astronomy, mathematics, and physics; chemistry; geology; zoology; geography; economics; engineering; anthropology (man looks in a mirror); physiology (a heart and microscopes); psychology (studying a dream); botany (trees and flowers); education (reading a book); and agriculture. There are probably many members of the

FIG. 1.

Association, as well as others, who will like to possess this humorous and apt memento of a notable meeting, in addition to those who ordered it during the excursion.

AT a meeting of the Royal Society of Edinburgh held on June 7, 1920, H.R.H. the Prince of Wales was elected an honorary fellow in accordance with the terms of Law VIII., which provides that "Personages of the Blood Royal may be elected Honorary Fellows at any time on the nomination of the Council." A special meeting of the Society was summoned on December 3 last, at which His Royal Highness was admitted to the honorary fellowship. As in the case of the sister and older Society, the Royal Society of London, the patronage of the reigning King was solicited as soon as it came into being, and a Charter of Incorporation was granted in March 1783. Since then the head of the Royal House, down to and including H.M. King George, has always been an honorary fellow of the Society. The first president was Henry, third Duke of Buccleugh, who communicated in 1785, to Volume I. of the Transactions, an abstract of the register of the weather for ten years kept at Branxholm, near Hawick, a residential seat of his family. The Duke wrote, in this first issue, a dedication to the King and Founder, George III., prefacing the papers published. "If they," he says, "shall be found worthy of the approbation of a Monarch who has distinguished his reign by the utility of his institution for improving the elegant Arts, as well as by the splendour and success of his undertakings to extend the knowledge of Nature, the Royal Society of Edinburgh may hope to occupy a respectable place among those bodies of learned men who, by their united efforts, have contributed so eminently to the progress of Science and of Taste in Europe." The Society now numbers on its roll some 650 fellows.

SERIOUS psychical research has been handicapped so often by the pretences of charlatans that the integrity of an investigator has to pass vigilant scrutiny before his testimony is accepted. It is therefore peculiarly interesting when men like Prof. Gilbert Murray and Lord Balfour give evidence of their first-hand experiences in telepathy. At a meeting of the Society for Psychical Research on December 12, Mrs. Henry Sidgwick described some instances of telepathy shown by Prof. Murray, and she stressed the fact that far from Prof. Murray desiring to prove a preconceived theory, he discovered his telepathic gifts when he was still a sceptic, and, even now, regards his demonstrations more as "parlour-tricks" than as serious investigations. The demonstrations were conducted in the following manner: some one, acting as "principal agent," thinks of the matter—a real or fictitious scene or quotation—which he wishes to convey to Prof. Murray, and describes it aloud to the other people in the room. Prof. Murray is then fetched from another room or some distance in which he has been waiting, and, lightly touching the principal agent's hand, attempts to reproduce the description. His percentage of successes (59 per cent.) and wealth of detail seems to preclude the possibility of coincidence. Mrs. Sidgwick also gave evidence against the view that hyperæsthesia is an explanation of telepathy, showing that no auditory hyperæsthesia could have enabled Prof. Murray to describe incidents, previously unknown to him, which were thought of, but not spoken of, by the agent. Sir Oliver Lodge and Lord Balfour supported the view that telepathy is more than strong sensory activity, and the latter described some successful instances in which he himself had acted as principal agent. The chairman (Mr. Piddington) described the experiments as "the most remarkable experiences of telepathy that the Society had ever had."

FOG under its worst conditions prevailed over England with unusual persistence for three days from Tuesday night to Friday morning, December 9-12. In London and the suburbs the smoke mixing with the fog greatly aggravated its intensity, and both for density and continuance the fog was the worst experienced for many years past. Thick fog was also reported from the midland, eastern, southern, and western districts of England, and from northern France, Belgium, and Holland. Few winters of late have been specially foggy, although there have been some instances of dense fog. In the winters of 1879–1880 and 1890–1 fog was both frequent and dense. Most winter fogs occur in otherwise fine weather with anticyclonic conditions, which are similarly characteristic of fine, dry, and hot weather in the summer. Registration of atmospheric pollution during the fog shows very distinctly its unhealthy and dangerous character. Fogs have often been discussed by meteorological authorities, but that in no way tends to lessen their occurrence or harmful character. The only known purifier is the springing up of a steady or strong wind, by which it is quickly dispersed.

DR. ARTHUR W. HILL, Director of the Royal Botanic Gardens, Kew, attended a meeting of the Jamaica Standing Committee of the West India Committee on December 10, when the question of deforestation was discussed. Dr. Hill directed attention to the grave effects which deforestation is having on the climate and cultivation of Jamaica, and it was decided to urge the Government of the Colony that effect might be given to the recommendations contained in the report of Mr. E. D. M. Hooper, of the Indian Forestry Department, upon the forests of Jamaica, which was published in 1886, so far as they were applicable to the present situation. It was further decided to urge that the existing laws in respect of the prevention of bush fires might be rigidly enforced.

DR. ALEXANDER RUSSELL has been elected president of the Junior Institution of Engineers for the session 1924–25. His inaugural address will be delivered at the Royal Society of Arts on Wednesday, January 7, at 7.30.

THE Right Hon. James Ramsay MacDonald and Sir David Prain, formerly Director of the Royal Botanic

Gardens, Kew, have been elected trustees of the British Museum in succession to the late Sir Archibald Geikie and the Right Hon. E. S. Montague.

THE annual meeting of the Mathematical Association will be held at the London Day Training College on Monday and Tuesday, January 5 and 6, when the following communications will be presented: on Monday evening, "The Mathematical Laboratory: its Scope and Function," Prof. H. Levy; on Tuesday morning, "The Neglect of Arithmetic in Schools," Prof. J. E. A. Steggall; "An Application of the Bessel Functions to a Problem in Optical Resolution," A. Buxton; and a discussion on "Tangency and Limits in Geometry"; on Tuesday afternoon, "What is Geometry?" Prof. G. H. Hardy (Presidential Address), and "The Reform of University Mathematics," Dr. H. B. Heywood.

THE annual exhibition of the Physical Society of London and the Optical Society is to be held on Wednesday and Thursday, January 7 and 8, at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, from 3 to 6 P.M. and from 7 to 10 P.M. Mr. F. Twyman will lecture on "Some Experiments with Interferometers" at 4 P.M. on January 7 and at 8 P.M. on January 8, and Mr. C. F. Elwell on "Talking Motion Pictures" at 8 P.M. on January 7 and at 4 P.M. on January 8. These lectures will include demonstrations. More than fifty firms are exhibiting scientific apparatus, and a number of experimental demonstrations have been arranged. Invitations have been given to the Institutions of Electrical and Mechanical Engineers, the Chemical Society, the Radio Society of Great Britain, the Röntgen Society, and the Faraday Society. Admission in all cases will be by ticket only, and members of the above societies should apply to the secretary of the Society to which they belong. Others interested should apply direct to Prof. A. O. Rankine, hon. secretary of the Physical Society, Imperial College of Science and Technology, South Kensington, S.W.7.

MR. CHARLES W. J. TENNANT, writing from the office of the district manager of the "Christian Science Committees on Publication for Great Britain and Ireland," says that the references to "Christian" science in letters in NATURE of December 6 are misleading. We are afraid we cannot enter into a discussion of the basis and meaning of Mrs. Eddy's work or the use of the term "Christian scientist" to denote a disciple of it, but it is of interest to give the following extract from Mr. Tennant's letter: "Christian Science is a perfectly legitimate term; it is the Science or knowledge of Christ, Truth; it is exact Science, and can be demonstrated as certainly as mathematics. One of the many definitions of the word 'science' in the Oxford Dictionary is 'organized body of the knowledge that has been accumulated on a subject.'"

THE Imperial Forestry Institute at Oxford started work on October 13, temporary accommodation having been provided in the School of Forestry building until arrangements can be completed for the erection of new buildings on another site. The board of governors of the Institute is now fully constituted as follows: Lord Clinton, Forestry Commissioner (chairman); the Vice-Chancellor of Oxford University, Mr. J. Wells; the President of Magdalen, Sir Herbert Warren; Prof. W. G. S. Adams; Mr. R. L. Robinson, Forestry Commissioner; Major R. D. Furse, Colonial Office; Col. G. L. Courthope, Empire Forestry Association; Prof. R. S. Troup. The following staff has already been appointed: Director, Prof. R. S. Troup; Secretary, Mr. P. S. Spokes; lecturers—economics of forestry, Mr. W. E. Hiley; silviculture, Mr. H. G. Champion; mycology, Mr. W. R. Day; structure and properties of wood, Mr. L. Chalk. The Institute will, in addition, have the assistance of the following members of the staff of the School of Forestry: forest management, Mr. R. Bourne; surveying and engineering, Mr. N. F. MacKenzie. The Forestry Commissioners have agreed to station at the Institute certain of their research officers.

THE Division of Medical Education of the Rockefeller Foundation has decided to collect and publish from time to time brief descriptions of clinics, laboratories, and methods of teaching in different parts of the world in order that the information in convenient form may be brought to the attention of those interested, and the first of these reports has been recently issued (Methods and Problems of Medical Education, First Series, 1924). It includes descriptions, with plans and illustrations, of seven anatomical institutes, including that at University College, London, of two departments of obstetrics (Harvard and Peking), and of the pathological institute at Graz. In each case a sketch is given of the courses of instruction and method of teaching.

PROF. HORST OERTEL, of McGill University, contributes to the *Scientific Monthly* (Nov. 1924, p. 512) an interesting and learned article on the relation of philosophy to medicine. He points out that pathology, for example, the science of disease, has not yet learned to distinguish fully between what is scientifically established and what is assumed. When we speak of bacteria as *causes* of disease, we are, strictly speaking, not correct, and all sorts of indefinite, largely hypothetical conceptions have been introduced, such as virulence, attenuation, variability, resistance, strains, individual susceptibility. All these cover up deficient knowledge of causal relations, and are, at the best, heuristic. Prof. Oertel pleads for a return to Immanuel Kant, to whom we owe so much as a pathfinder of correct scientific thought and reasoning.

THE Department of Health, Canada, has issued a striking pamphlet (Publication No. 32) on "Smallpox and Vaccination," by Dr. J. J. Heagerty. The symptoms and history of smallpox are briefly described, a few statistics of its incidence and mortality are given, and the nature of vaccination detailed. But the salient feature, apart from scarlet covers, is the number of excellent reproductions of photographs,

some showing the disease at its worst, others mild cases and after-effects. But the two most striking illustrations depict, one a smallpox mother nursing with impunity her vaccinated baby, the other three children of the same family, the middle one of the group unvaccinated and covered with the smallpox eruption, while on either side is a child vaccinated a year previously, neither of whom took smallpox though living in the smallpox ward for several weeks.

THE Bulletin of the Imperial Institute, Vol. 22 No. 3, 1924, contains a very full account of the cultivation and propagation of the banana, its transport to the British market, and also its possible utilisation as "flour" or dried slices, "figs." An account is also given of the more usual fungus and insect pests which the banana cultivator has so far had to struggle against. Provided rainfall or irrigation can supply sufficient water in a tropical climate, the banana can be grown successfully on many soils if labour is available; and as at present the greater part of the imports to the United Kingdom come from foreign countries, it is suggested that tropical areas within the Empire might take a greater share in the production of this crop, particularly perhaps West African regions within a comparatively short distance of the home markets. Two species of banana are grown on the commercial scale, a variety of *Musa sapientum* known as "Gros Michel," the principal banana grown in Central America and Jamaica, and *Musa Cavendishii* or *M. sinensis*, a native of Southern China, which was introduced into the Canary Islands, a smaller form than "Gros Michel," of less robust habit, and therefore requiring protection in crates when exported; this is now usually known as the Canary Islands banana.

THE library of the Chemical Society will be closed for the Christmas holidays at 1 P.M. on Tuesday, December 23, and will reopen at 10 A.M. on Monday, December 29.

READERS on the look-out for book bargains should obtain a copy of Catalogue No. 244, just issued by Messrs. W. Heffer and Sons, Ltd., Cambridge, which gives particulars of nearly four hundred "remainders" now offered at greatly reduced prices. Many works of scientific interest are included.

MESSRS. W. Watson and Sons, Ltd., 313 High Holborn, London, W.C.1, have recently sent us a copy of a new edition of their Catalogue of Microscopic Objects. The list is divided into sections, each of which is limited to preparations referring to a particular subject, and in each section related specimens are conveniently grouped under sub-headings. There are also several special educational sets of representative slides. The list covers botany, geology, histology, pathology and zoology, and accessories for microscope technique.

Our Astronomical Column.

THE JOHANNESBURG REFRACTOR.—Dr. Innes was able to give the welcome news at the R.A.S. on December 12 that the object glass of the 26½-inch refractor at the Union Observatory, Johannesburg (made by Messrs. Sir Howard Grubb and Sons, Ltd.), was at last on its way to Africa. It was ordered fifteen years ago, but the War brought work to a standstill. The flint lens is not quite perfect, being slightly veined, but the effect on its optical performance is fortunately trifling.

Dr. Innes spoke of the difficulty of finding sufficient workers to man the large telescopes in the southern hemisphere. After describing the arrangements made for interchange of observers with Leyden Observatory (Mr. Van den Bos is going to observe double stars), he implied that there was still room for further volunteers if the telescope was to be worked to its full capacity.

The fact of there being more than 300 fine nights each year makes a number of observers desirable.

COMBINED OBSERVATIONS OF THE MOON.—At Prof. E. Brown's request, an international plan of intensive observation of the moon during the three months December, January, February is being undertaken, in order to fix the errors of the new tables as accurately as possible. The total eclipse of the sun which occurs in January in the United States will fill in the gap which usually occurs at new moon; it enables the moon's latitude to be fixed with great accuracy. Amateur observers can help by observing occultations, accurate time being now easily obtainable by wireless signals.

Dr. H. Spencer Jones, H.M. Astronomer at the Cape, has just communicated to the R.A.S. a valuable discussion of the occultations observed at the Cape during the last 40 years. They give a value of the solar parallax practically identical with that deduced from observations of Eros in 1900–1, namely 8·806″. He also found a value of the semidiameter of the moon 15′ 32·70″, which is only 0·05″ in excess of that deduced by Struve from numerous observations during lunar eclipses.

THE BAADE PLANET.—The orbit of this body is now accurately known, the following elements having been deduced by Dr. Stracke, of the Berlin Rechen-institut, from observations extending over 32 days.

Perihelion passage, 1924, Sept. 28·38252 G.M.T.

$$\left.\begin{array}{lll} \omega & 130^\circ\ 35'\ 43{\cdot}8'' \\ \Omega & 216^\circ\ 26'\ 19{\cdot}0'' \\ i & 26^\circ\ 9'\ 4{\cdot}0'' \end{array}\right\} 1924{\cdot}0$$

$$\phi \quad 32^\circ\ 37'\ 35{\cdot}5''$$

Period, 4·35326 years.

Least distance from sun, 1·22867: greatest, 4·10353.

Three periods are very close to 13 years, and it is just 13 years since Albert was discovered, the orbit of which resembles it in everything except inclination; but that is only 11° instead of 26°. Also the new body is 4 magnitudes brighter than Albert, implying a diameter of some 20 miles instead of 3 miles, so identity seems impossible (though it was suggested by Dr. Stracke), but there may be some connexion between the bodies. It should be possible to photograph the new body even in aphelion oppositions. It will then be of about the 16th mag.

The least distance from Jupiter's orbit is about 2 units, being increased by the large inclination. The perturbations are considerable, but not excessive, and could not explain the change of inclination from 11° to 26°.

An interesting point is that the orbit approaches that of Mars within 3½ million miles, which is near enough to produce sensible perturbations.

Research Items.

THE PEARL IN OCEANIA.—The prominence given to pearls by Prof. Elliot Smith and Mr. W. J. Perry in their theories relating to the diffusion of culture, has led Dr. A. C. Haddon to make a careful examination of the evidence. The result is published in *Man* for December. Prof. Elliot Smith founded his argument upon the word *Margam*, which he stated meant in Ancient Persian "pearl" and "giver of life"; whereas it means "coral," and the interpretation "giver of life" is based upon an impossible etymology. Mr. Perry accounted for the activity of the colonisers of Oceania in certain areas by attributing it to the love of the islanders for pearl and pearl shell. An examination of the earliest writers on the Pacific shows that of all the natives of the Pacific, the Society Islanders alone had any enjoyment of pearls. When pearls are mentioned elsewhere they appear to have been obtained for the purpose of barter with the Spaniards. In Otaheite, early travellers bear witness that the women wore an ear ornament consisting of three pearls strung together. There is no evidence, however, that pearls had any special significance beyond that. Nor is there in Polynesia any general word for pearl in current use as would have been expected on Mr. Perry's view. The pearl-shell was the essential object, and the pearls were named from it. If the pearl were the prime object of interest to the "archaic" colonisers, it is difficult to see why the original name should have been lost and a derivative name substituted. In Malaysia the terms for pearl and shell suggest that the use was introduced by the Hindus. Pearl shell was both worn and used by Papuans and Melanesians when first we hear of them. There seems to be only one reference to its magico-religious significance. This is recorded by the Rev. Dr. C. E. Fox.

BEISAN FROM THE AIR.—Mr. Clarence S. Fisher has published in the *Museum Journal* (Philadelphia) for June last three photographs, taken from the air, of the excavations of the expedition of the University of Pennsylvania to Beisan. These photographs are part of a series taken by the XIVth Squadron of the Royal Air Force with the permission of the General Officer Commanding in Palestine, which forms a valuable addition to the permanent records of the expedition. The first of the photographs reproduced shows the citadel of Beisan from the east and gives an idea of the magnitude and symmetrical shape of the hill which cannot be obtained from the ordinary photograph. The second view shows the extent of the excavations up to the present, while the third gives a survey of the whole country between Mount Gilboa and the River Jalud which runs at the foot of the main hill of the site. This last is a striking example of the value of the aeroplane in archæological work as it shows how this isolated fortress dominated the area once famous for its fertility, but now mostly occupied by swamps, in a way that would not be possible either in a verbal description or in a photograph taken on ground level.

BIRD-MARKING IN AMERICA.—We have received a paper by Mr. F. C. Lincoln on "Returns from Banded Birds, 1920 to 1923," forming Department Bulletin No. 1268 of the U.S. Department of Agriculture. It consists mainly of tables giving particulars of 1746 records of marked birds recovered in a period of three and a half years, from which figures it is apparent that this method of studying migration has been greatly developed in the United States since the War and is now being exploited on a larger scale. It is of interest to note that this is largely due to its having been taken up officially by the Bureau of Biological Survey of the Department of Agriculture, an organisation which has for long paid much attention to bird-migration, as is witnessed by the well-known work of another of its officers, the late Wells Cooke. One may judge, accordingly, that the importance of seasonal movements in the study of economic ornithology is fully realised. (A parallel is to be found in Hungary alone among European countries.) The new method has evidently been applied with efficiency and thoroughness, and the form adopted for preliminary publication is a useful one. Future papers may be expected to give some analysis of the results and conclusions drawn therefrom, but here this is not attempted. There is, however, a map showing the recovery localities of a large number of mallard marked in Illinois in the spring, autumn and early winter; these are spread over a vast region from the mouth of the Mississippi to Saskatchewan. The results are interesting for purposes of comparison with those already obtained for the same species in Europe, and notably in the British area.

THE MARINE FISHES OF PANAMA.—In an important and exhaustive paper (Field Museum of Natural History, Zoological Series, vol. xv.) S. E. Meek and S. F. Hildebrand give an account of the marine fishes collected during the biological survey of the Panama Canal Zone. They make the review of the fishes of this district complete by including all previously recorded species. The collections were made on both sides of the Isthmus, and the authors find that the Pacific fauna, on the whole, is the richer. They agree that the ichthyological evidence is overwhelmingly in favour of the existence of a former open communication between the Atlantic and the Pacific, sufficiently remote, however, to have permitted the specific differentiation of forms on the two coasts. Seventy-two species are common to the two coasts, but of these, forty-eight are cosmopolitan in their distribution. Two new genera and twenty-three new species are instituted in the first part of this report.

FUNGI FROM NORTH GREENLAND COAST.—As No. 12 of Part II. of the report of the 1916–18 Danish expedition to the North Coast of Greenland, J. Lind has recently described the fungi collected there by the late Dr. Th. Wulff. A point of some interest is the fact that only one parasite, *Melampsora arctica*, is present in the collection, whilst many saprophytes are included, mainly very small Pyrenomycetes and Discomycetes, nearly all of which are invisible to the naked eye, so that the 46 species described would seem a great tribute to the energy and discrimination of the collector. Lind points out that the prevalence of saprophytic forms in North Greenland is undoubtedly due to the fact that the dead parts of plants do not rot away as in more southerly latitudes, "but remain during one or several years forming a protective coating around the young buds and shoots." These old, withered leaves and stalks constitute an excellent substratum for small saprophytes.

CYTOLOGY OF COTTON.—Mr. Humphrey John Denham has published the results of extensive studies of the cytology of cotton in two papers in the *Annals of Botany* (vol. 38, pp. 407-438, 1924), paying special attention to microspore development. The haploid chromosome number proves to be 26, two chromosomes being distinctly larger than the remainder. The author has counted the chromosomes in some 32

varieties of cotton and arrives at the interesting result that the cottons of the New World and Egypt uniformly possess 26 chromosomes, whilst those of Asia have 13 chromosomes. This result probably throws some light upon the difficulty of successful crossing between Indian and American or Egyptian cottons and is therefore of considerable interest to those engaged in the scientific development of cotton-growing within the British Empire. This is probably the reason why Mr. Denham's two papers are also printed in the Journal of the Textile Institute (vol. 15, No. 10, October 1924), but they will prove difficult to readers unaccustomed to technical botanical terminology in spite of the fact that they are preceded by a brief introductory note to which a glossary of technical terms is appended.

TERTIARY AND CRETACEOUS FOSSILS FROM THE ARGENTINE.—Our knowledge of Argentine fossils is not so extensive but that additions, however small, are welcome. Two small papers by M. Doello-Jurado are before us. The one (*Anal. Soc. Cient. Argentina*, tom. xciv.) describes under the name of *Mytilus pseudochorus*, n. sp., the cast of a mytiloid shell from the Santa Cruz formation that has lain some time in the National Museum of Natural History at Buenos Aires, and of which the likeness to *M. chorus*, Mol., had already been recognised by Von Ihering. The other communication (*Physis*, tom. v.) deals with a new species of Viviparus, *V. wichmanni*, from freshwater beds in the Upper Cretaceous of Rio Negro. The author's figures are not very clearly printed, and the doubt may be permitted whether most palæontologists would refer the specimen to Viviparus *sensu stricto*.

WELL-WATERS OF SOUTH AUSTRALIA.—Mr. R. L. Jack publishes three maps and a series of analyses on the well-waters of the South Australian part of the great artesian basin of Australia in the Trans. and Proc. of the Royal Society of South Australia, xlvii., 1923. He strikes another blow at the old view that their waters were all derived by annual percolation from the Queensland hills, by showing that some of it has come from the now arid regions of the very centre of Australia north-west of Lake Eyre. He shows that these waters are of two chemical types, one rich in sulphate and the other in carbonate. The table of analyses records only the chlorine, CO_3 and SO_4. Mr. Jack accepts the view that there should be rigid control to prevent waste of water from the bores, as they are draining water of cisternage which ultimately will only be recoverable by expensive deep pumping. It is unfortunate for the Australian artesian basin that the wholesale waste of the water was so long permitted.

THE WATER-POWER OF SWEDEN.—The growing interest in water-power, especially in countries with little or no coal of their own, adds to the importance of a paper by Mr. S. Norlindh entitled "Översikt över Sveriges Vattenkraft" (*Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt*, Bd. I. No. 5). The publication is mainly statistical and gives very full data of all the important falls on more than 100 Swedish rivers and their main tributaries. For each is given the drainage area, weight and the theoretical horse-power. Other tables give the largest falls and the large falls at present utilised. From comparative statistics of various countries, Sweden with nearly 18 million H.P. appears to be better supplied with water-power than any other country in Europe, next coming Norway and France, each with about 12 million H.P. It is doubtful, however, if world statistics of this nature are altogether comparable since most are merely estimates founded in many cases on inadequate data. A notable part of the publication is a well-produced map of Sweden (scale 1 : 1,000,000) showing the location and horse-power of the chief falls with distinctive colouring for those which are now in use. This map shows strikingly how much power has been harnessed in the south of Sweden and the vast unemployed resources in the north of the country, notable exceptions being the falls on the Luleälv at Porjus and Harspränget in Swedish Lapland.

THE EARTH'S CRUST.—"The Composition of the Earth's Crust," by F. W. Clarke and H. S. Washington (Professional Paper 127, United States Geol. Survey, Washington, 1924), sets out in detail the results obtained by these authors in their most recent examination of the best analyses of igneous rocks available up to the present time. A summary of these results was published in the Proceedings of the National Academy of Science (1922, vol. 8, p. 108), and referred to in NATURE of August 19, 1922, p. 253, where an analysis of the average igneous rock of the earth's crust, and the estimated percentages of the commoner elements in the lithosphere, hydrosphere, and atmosphere, according to Clarke and Washington, were given. The figure obtained is the average of 5159 analyses of specimens of igneous rocks, and should correctly be described as such, rather than as the average igneous rock of the earth's crust. This may be best realised from a consideration of the fact that, of the 5159 analyses, 1985 represent Europe, 1709 North America, and 1465 the rest of the earth. The Pacific is represented by 72 analyses of rocks from Polynesia. On p. 19 of their paper the authors quote the Italian proverb: "Chi va piano va sano." They themselves, however, fail to exemplify the teaching of this good old proverb, for they proceed at an unsafely quick pace when they infer that an average of the available analyses of specimens of igneous rocks shows the average composition of the earth's crust.

UPPER AIR OBSERVATIONS.—Successful results of observations in the upper air by means of *ballon sonde* and pilot balloon are given in the *Meteorological Magazine* for October and November. A Dines meteorograph, according to the number for October, was sent up from H.M.S. *Kellett* in the English Channel on June 16. Two balloons were employed in tandem. The apparatus fell into the sea near Eastbourne and was returned to the Meteorological Office. The lifter balloon was followed by means of glasses and is thought to have burst at a height of about 12 km. (7 miles). At sea-level the atmospheric pressure was 1014 mb. and the temperature 68° F.; at 3 km. (1·8 miles) pressure was 709 mb. and temperature 43° F.; at 5·4 km. (3·3 miles) pressure was 520 mb. and temperature 12° F. Two *ballon sonde* ascents were made from the meteorological station at Sealand Aerodrome, near Chester, on July 14 and 15, each of which reached a height of about 20½ km. (12·3 miles); this is the greatest height reached in Great Britain for 12 years. The November number gives a note on a high pilot balloon ascent at Shoeburyness on May 28. The balloon was followed with two theodolites up to a height of 50,000 ft. (9·5 miles), when the home station lost it. The ascent reached well into the stratosphere. To a height of 16,000 ft. the wind was south-easterly with a speed of 10 m. per hour; it veered to south at 25,000 ft., and beyond this height it continued to veer becoming south-west, 20 m.p.h. at 30,000 ft.; beyond 40,000 ft. it backed slowly and decreased. At 50,000 ft. the wind was west or west by south and very light. At the time of the ascent there was a depression far out in the Atlantic and an anticyclone extended eastward from the southern Baltic; the pilot balloon thus showed the southerly circulation between the two.

PERIODICITY OF TEMPERATURES IN EUROPE.—A. Wagner, in a paper read at the Academy of Sciences, Vienna, in July of this year, presented evidence for the existence of a 16-year periodicity of temperature in Europe, based on the examination of long series of data for Vienna and other stations. He finds that the phases of this cycle are opposite in summer and winter, so that it is best seen in the annual range. The amplitude is greatest in Central Europe, whence it decreases southwards and especially northwards, but the phase remains constant. Along a line from Stykkisholm through Stockholm to Petrograd the periodicity vanishes, to reappear farther north with the phases exactly reversed. The author is quite satisfied as to the reality of the periodicity, but until the full evidence is available it would be premature to express an opinion. It should, however, be pointed out that if the periodicity is as definite as the author claims, its length is not sufficiently defined. A cycle of 16 years may imply anything between 15·5 and 16·5 years. If it is real, the series of 147 years' observations available at Vienna should be quite sufficient to determine the length to one place of decimals. If every discoverer of a periodicity would set himself to calculate accurately its length and amplitude before giving it to the world, there would be less confusion in the subject.

THE ELECTRICAL CONDUCTIVITY OF ROCK-SALT CRYSTALS.—A very comprehensive investigation of the electrical behaviour of rock-salt, at temperatures ranging from 15° to 500° C., is described by Dr. D. v. Seelen in the *Zeitschrift für Physik*, October 23. It was found that all the specimens available required a preliminary treatment by heating to 400° ; measurements made before this treatment did not agree with those made under similar conditions afterwards, but the effect of the heating was to give a material which had a fairly definite conductivity and temperature coefficient for each temperature. One of the experiments, in which three polished plates were carefully weighed, piled between silver plates, heated to 400° C. for several days while a current was passed through them and again weighed, showed that conduction took place according to Faraday's law, and was electrolytic in character. Sodium ions (Na^+) are the only carriers of electricity, and chlorine ions (Cl^-) do not travel through the crystal. The distribution of potential along the length of the crystal was investigated ; it does not follow the straight line law, and space charges in the interior of the crystal have to be assumed. There is nothing which alters the potential distribution, such as double layers or space charges, at the electrodes. The author considers that his experiments indicate a loosening of the crystal lattice as a preliminary to conduction ; under the conditions of his experiments the formation of metal bridges in the crystal lattice was not possible, and the fact that the crystals did not lose weight when heated all day to 400° excluded the possibility that conduction was due to salt solution included in the crystal.

RANGES OF POLONIUM α-RAYS IN OXYGEN AND NITROGEN.—Mlle. I. Curie, using air in the Wilson apparatus, formerly obtained a very different result for the above distribution than that given by the scintillation method, and found that the latter does not detect the majority of the rays towards the end of their range. In the *C.R. Acad. Sci. Paris*, Oct. 20, Mlle. Curie and Mr. N. Yamada describe measurements in oxygen and nitrogen. The number of particles with ranges between x and $x+dx$ is proportional to $\epsilon^{-\xi^2/\alpha^2}$; $\xi=x-\rho$, ρ being the most probable range, and α an experimental constant. The value of α/ρ for nitrogen is 0·0208, for oxygen 0·0208, and that previously found for air is 0·015. The exact equality of the values of α/ρ for oxygen and nitrogen is partly fortuitous, the difference in the case of air being due to the greater thickness and possible irregularity of the preparation and impurities. It appears that the difference in the form of Bragg's ionisation curves for oxygen and nitrogen is due to the law of variation of ionisation along the α-ray, and not to any difference between the distribution of ranges in the two gases.

HALIDES OF SILVER.—The photochemical decomposition of silver bromide has recently been investigated by E. J. Hartung with the aid of the microbalance (Jour. Chem. Soc., November). It is interesting to note that experiments on the rate of bromination of thin films of metallic silver afforded no evidence of the formation of silver sub-bromides or perbromides. Thin films of silver bromide, when sealed up in a vacuum in the presence of copper gauze and placed in the light, lose more than 96 per cent. of their bromine. These results support the non-existence of silver sub-halides, and they bear out the conclusions reached by Reinders in 1911 and Bancroft in 1923.

ELECTRO-ENDOSMOSIS.—A contribution to the study of electro-endosmosis, by F. Fairbrother and H. Mastin, appears in the Jour. Chem. Soc. for November. The calculation of the potential gradient along the walls of the capillaries in the diaphragm of an electro-endosmose apparatus involves uncertain assumptions, and a method is described for overcoming these difficulties. In effect, the method consists in measuring the "cell-constant" of the diaphragm, the conductivity of the calibrating liquid being assumed. Measurements with carborundum powder in acid and alkali are recorded ; the electrokinetic potential, calculated from the modified Helmholtz equation, reaches a maximum in dilute alkali ; it decreases as the concentration of the latter decreases and as the concentration of the acid increases. At the intermediate point (water) the carborundum is negatively charged ; the value −0·0698 volt is found for the potential between the two parts of the double layer in distilled water. No reversal of the direction of electro-endosmosis was found with carborundum in hydrochloric acid solutions up to N/50 strength.

THE ATOMIC WEIGHT OF ANTIMONY.—In the November number of the Journal of the American Chemical Society, P. F. Weatherill describes experiments on the atomic weight of antimony. Antimony trichloride, prepared from pure antimony and chlorine in a vacuum, was repeatedly distilled in a vacuum in an all-glass apparatus. It was dissolved in a solution of pure tartaric acid, and compared with pure silver. The mean of nine analyses gave Sb = 121·748 ± 0·00086, which may be compared with the value 121·77 obtained by Willard and McAlpine from the analysis of the tribromide, and the value 121·76 obtained by Hönigschmidt from the analysis of both the tribromide and the trichloride. By taking all three independent researches into account, a value of 121·76 would seem to be close to the truth. The value 120·2, which has appeared in the tables for a number of years, is much too low. It may be remarked incidentally that no atomic weight table appears to have been published by the International Commission since 1921, and that a new table would seem to be due. Differences of the order indicated affect ordinary analytical practice.

Crystal Structure.

DURING the Toronto meeting of the British Association, Sir William Bragg's presidential address was followed by a discussion on crystal structure.

Prof. W. L. Bragg described the manner in which the refractive indices of certain crystals, the structure of which has been determined by X-ray methods, can be quantitatively explained. In calcite, for example, the arrangement of atoms in the planes perpendicular to the trigonal axis consists alternately of calcium ions and CO_3 groups arranged at the corners of a triangular network. The three oxygen atoms are closely packed round a central carbon atom and lie parallel to the planes. Wasastjerna has given reasons, based on the similarity of the refractivities of the molecules or ions Al_2O_3; SO_3; NO_3 and CO_3, for assuming that the refractivity in such groups is to be ascribed to the *oxygen* atoms.

If, then, the carbon atom in the CO_3 group is left out of account, it appears that an electric field perpendicular to the trigonal axes, and so parallel to the plane of the CO_3 group, causes a polarisation of the oxygen atoms which is greater than it would be for an isolated atom. On the other hand, an electric vector perpendicular to the CO_3 plane produces a less polarisation than it would do for a single atom. This polarisation is equivalent to the creation of a set of electric doublets the moments of which will be greater in the first case than in the second. It is evident that the velocity of a wave in the crystal, depending on the ratio of the total polarisation per unit volume and the intensity of the electric field, will be less when the electric vector is perpendicular to the trigonal axes than when it is parallel to these axes. The crystal has a high refractive index for light with its electric vector parallel to the CO_3 planes or perpendicular to the trigonal axis, but a low refractivity for light having its electric vector perpendicular to these CO_3 planes.

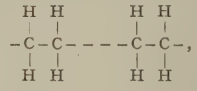
It is possible to calculate the polarisation of the atoms of calcite under a given field. Since the relative positions of the atoms are known, it is possible, by making the assumption that the polarised atom has an external field identical with an electric doublet placed at its centre, to calculate the two refractive indices.

Values of the refractive indices calculated for calcite and aragonite, both crystalline forms of calcium carbonate, show very good agreement with observed values.

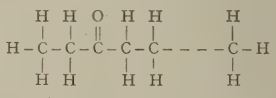
Prof. S. Chapman explained how he and Prof. W. L. Bragg had attempted theoretically to calculate the rhombohedral angles of crystals of the calcite type. A number of carbonates form rhombohedral crystals similar to calcite, having an angle between the crystallographic axes of about 102° for the whole series. The calcite type of crystal has the form of a cube shortened along a diagonal (its trigonal axis) and consists of ions of the form R^{++} and CO_3^{--}. The CO_3 planes, as described above, are perpendicular to this axis. It is, therefore, possible to picture a distortion of this crystal along a trigonal axis such that the type of the lattice is preserved, and the distance between neighbouring oxygen-metal or carbon-oxygen centres is constant. It is found that the electrostatic potential energy per gram molecule of calcite, when calculated for a series of such positions, has a minimum value for an axial angle of about 106°. The difference of 4° can be accounted for as being due to the simplicity of the assumptions underlying the calculation. The *variation* of the angle in a group of crystal-carbonates containing different metallic ions can be accurately accounted for by the different sizes of the metallic ions.

When considering the arrangement inside a crystal, it is obvious that the atoms must be held in position by forces symmetrically disposed. This symmetry disappears at the surface, so the surface layers must possess properties different from those of the mass. Prof. C. H. Desch described experiments made with gold, showing that the cohesion and surface tension of a crystal do not necessarily decrease at the same rate with rise of temperature. The surface tension at high temperatures is sufficient to round the sharp angles of a crystal, so that beads of gold slowly cooled have a skin resembling a film of gelatin over them. This can be removed by etching to expose the normal structure.

In discussing the structure of the long chain carbon compounds, Dr. Shearer emphasised the fact that the measurements he and Dr. Müller had made pointed to the existence of a simple relation between the dimensions of a single molecule and the dimensions of the crystal cell. When X-ray spectrograms of compounds are measured which have a structure based on the chain

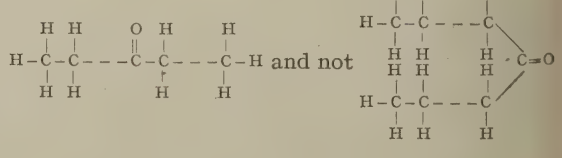


it is found that the most prominent lines are due to one spacing which is much larger than the others. For substances which differ only in the number of CH_2 molecules in the chain there is a regular progressive increase in the size of this spacing as the number of CH_2 groups increases. Frequently, if the number of carbon atoms in such a chain is plotted against the spacing, the points lie on a straight line, and approximately the spacing is either equal to or twice the length of the molecule. The double spacing is characteristic of molecules having an active group at one end; hydrocarbons, esters, and ketones, which have no active group at the end, show the single molecule spacing. For example, measurements of a ketone series such as



gave a single molecule group. It is interesting to note, however, that five methyl ketones, in which the oxygen is attached to the penultimate carbon atom, gave the double spacing. When the spacing of these methyl ketones is divided by two, these compounds take their place on the straight line representing the other ketones. Evidently in the methyl ketones the oxygen is sufficiently near the end of the chain to behave as an active group. This result indicates the effective range of attraction of the oxygen atom.

There are three rates of growth indicated for chain compounds, appearing to show that the CH_2 molecule can occupy three different lengths in the chain. Suggestions have been made to account for this variation in length by different arrangements of the carbon atoms in the chain. These measurements appear to give a real meaning to stereochemical formulæ. It appears, for example, that ketones have the structure



The spectra of double molecule chains give, as one would expect, strong odd orders and weak even, whilst the single chains give orders decreasing uniformly in intensity.

Mr. S. H. Piper gave some examples of the use of X-ray spectra in distinguishing between long chain compounds of similar types. It was possible to show that the fractions obtained by distilling paraffin wax *in vacuo* were not identical with normal hydrocarbons. For example, one fraction having the same number of carbon atoms in the chain as dotriacontane showed a very much smaller spacing. All fractions appeared to photograph as pure substances, and it was interesting to notice that the lines shown by a film of crude paraffin wax melted on glass gave the same spacing as one of the eight fractions. On mixing this fraction with one or more of the others, its lines only appeared on the plate.

Dr. Müller mentioned that the main spacing given by certain hydrocarbons appeared to have two possible values, indicating two possible crystalline structures for these substances.

Mr. W. T. Astbury indicated how it is possible to determine from X-ray measurements, by making use of the theory of space groups, the elements of symmetry possible to the molecules in the crystal cell. It is then possible to distinguish between two or more structural formulæ for a given compound. A most valuable series of tables was shown giving the possible molecular symmetry for all the 230 space groups.

Oyster Mortality in 1920.

PART I. of the report under notice [1] was reviewed in NATURE of July 19, p. 82. It contained Dr. Orton's Final Report, while Part II. commences with his Interim Report of December 30, 1920, which apparently is now published for the first time. It shows the preliminary biological investigations that were made by Dr. Orton, together with his examination of the dumping-ground for explosives in the Black Deep, and is altogether admirable. Why this was not printed in proper sequence, these being the preliminary conclusions of the same author, it is impossible to understand. Further, if it had been published as soon as received instead of in 1924, it would have relieved the minds of those concerned with the oyster industry, and probably elicited from them much further information, besides stimulating and directing their own observations; those responsible for the industry are not unheeding of the results of scientific research.

Dr. Orton's interim report is followed by a series of valuable research reports on special questions. Dr. Eyre's very thorough investigations, mainly shown in tables, lead to the conclusion that no evidence points to the excessive mortality being due to *disease* of bacterial origin. Dr. Brady tested very thoroughly from the chemical side and came to a similar negative conclusion in respect to the dumped munitions of war. The Government Chemist and his staff in four reports are largely concerned with arsenic, which is very widely contained in silts formed from rocks containing arsenic. As diseased and healthy oysters have the same amount, this clearly cannot account for the mortality, nor is there any suggestion of the mortality possibly being due to "dumping" of arsenic compounds either by factories or by the Munitions Department. However, the possibility of arsenic in oysters being of danger to man is unavoidably raised, especially as the silts of the Fal contain large quantities of copper, zinc and tin also, whereas these are practically absent from the oyster grounds of the Thames estuary and the East coast. The present reports, critically examined in connexion with former researches, give no cause for any suggestion of danger to human life from these substances as consumed by the most gluttonous lover of oysters. Yet, we do not think these researches should stop here without a more definite examination and pronouncement on this question by the Government Chemist, whose staff must now have considerable experience in the necessary analyses, and who can consult as may be advisable with the expert physiologists of the Ministry of Health.

If the analyses of any oysters give any suggestions of danger, the beds from which those oysters come must clearly be closed for direct sales, the fish being first laid elsewhere for a period sufficient to remove the noxious substance, as is required for bacterial infections. What is first required, however, is a definite pronouncement as to what constitutes danger. Without this the present report will inevitably give rise to alarm, if it ever becomes known to the "man in the street." This is unlikely, however, as it costs 7*s.* 6*d.* for 69 pages, without illustrations, and free copies are not distributed. This is scarcely the way in which to make scientific research popular. Our Government authorities have much to learn from a study of the effect of a liberal free distribution of similar reports in the United States. J. S. G.

[1] Ministry of Agriculture and Fisheries. Fisheries Investigations, Series 2, vol. 6, No. 4, 1924: An Account of Investigations into the Cause or Causes of the Unusual Mortality among Oysters in English Oyster Beds during 1920 and 1921. Part 2: Chemical Reports, (1) by George Stubbs, Andrew More and John Ralph Nicholls, and (2) by Dr. O. L. Brady; Bacteriological Reports, by Prof. J. Eyre; Report on Field Work, by F. S. Wright; Biological Investigations, by Dr. J. H. Orton; Recommendations as to Further Research, by Dr. J. H. Orton. Pp. 69. (London: H.M. Stationery Office, 1924.) 7*s.* 6*d.* net.

The Thermal Efficiency of Steam Engines.

A DISCUSSION on the standards of comparison in connexion with the thermal efficiency of steam engines was held at the Institution of Civil Engineers on Thursday, December 11. The Heat Engine and Boiler Trials Tabulation Committee has appreciated the fact that the present standard of comparison needed development, and asked Capt. H. Riall Sankey to prepare a memorandum on the subject with a view to discussion at a joint meeting of the Institutions represented on the Committee (*v.* NATURE, December 6, p. 835). The 1896 Committee of the Institution of Civil Engineers, under the chairmanship of Sir Alexander Kennedy, proposed the Rankine cycle as a standard. Since that time the practice of heating the feed-water by live steam abstracted from the engine during expansion, known as "bleeding," has been developed, resulting in considerable economy, but to this case the Rankine cycle does not apply. The practice is also adopted of reheating the steam after a partial expansion, a process which can be repeated once or more, after which the steam is expanded to the back pressure, but it would be stretching the definition of the Rankine cycle to apply it to this case. Further, these feed-heating and reheating cycles can be combined, and the question arises, can a standard of comparison be defined that will meet all cases?

It is submitted that the following extended definition can be applied to all cases :

It is assumed that all the component parts of the steam plant are perfect, and that there are no losses due to initial condensation, leakage, radiation, or conduction, and that there is no clearance in the cylinder. The feed-water required is taken into the boiler at the exhaust temperature, and its temperature is gradually raised until that corresponding to saturated steam is reached. Steam is then formed at constant pressure until dry saturated steam is produced, after which, if the steam is to be superheated, heat is added at constant pressure and at increasing temperature, until the required temperature of superheat is reached. The steam is introduced into the cylinder at constant pressure, displacing the piston, and performing external work equal to the absolute pressure multiplied by the volume swept through by the piston up to the point of cut-off. Beyond that point expansion takes place adiabatically, doing work until any desired pressure is reached, when the steam is reheated at constant pressure to any desired temperature whence adiabatic expansion takes place ; such reheating process can be repeated as often as desired. Finally, the steam is expanded adiabatically until the temperature of saturation corresponding to the boiler pressure is met. From this point, *either* adiabatic expansion continues doing work until the pressure in the cylinder is equal to the back pressure against which the engine is working, *or* the steam is expanded so that a portion of the heat is transferred to the feed-water in such a manner that at every temperature the amount of heat so transferred is equal to the increase in water-heat at that temperature, until the pressure in the cylinder is equal to the back pressure against which the engine is working. The steam is then completely exhausted from the cylinder at constant pressure corresponding with the lower limit of temperature, work being done on the steam by the engine during exhaust, equal to the absolute back pressure multiplied by the total volume swept through by the piston. The steam is thus removed from the cylinder and the cycle is complete.

In practice, the following main cases occur resulting from the omission of one or more of the factors of the comprehensive definition :

(1) Saturated steam with simple adiabatic expansion to the back pressure.

(2) Superheated steam with simple adiabatic expansion to the back pressure.

(3) Superheated steam with one or more reheats with final adiabatic expansion to the back pressure.

(4) Saturated or superheated steam with feed-heating expansion to the back pressure.

(5) Superheated steam with one or more reheats, and final feed-heating expansion to the back pressure.

The thermal efficiency of any heat engine is defined as the ratio of the heat utilised as work to the heat supplied. Capt. Sankey gives some worked-out examples to illustrate the method, and makes use of the Mollier chart and of Callendar's Fahrenheit Steam Tables. He also includes tables of results of a large number of other calculations for different cases, and includes among these one illustrating the Benson cycle, in which steam is generated at the critical temperature (706° F.) at a pressure of 3200 lb. per sq. inch absolute. For comparison, the thermal efficiencies of a gas engine and of an oil engine have also been worked out and are included in the tables.

Capt. Sankey's memorandum gives some idea of the arduous task which the Committee has had to face, and the final recommendations will be welcomed by the engineering profession.

Parker Plant for Low Temperature Carbonisation.

ATTENTION has already been directed in NATURE (September 20, p. 441) to the Government offer to test at public expense approved processes for the carbonisation of coal at low temperatures. The Low Temperature Carbonisation Company, Ltd., has been quick to submit for test the standard unit of "Parker" plant installed near Barnsley at Barugh (locally pronounced "bark," it may be added for the enlightenment of the uninitiated). The Department of Scientific and Industrial Research has now issued a report of the test made in July last. The Director of Fuel Research in a prefatory note emphasises that the report is on technical results only, and that "no attempt is made to pronounce on the commercial possibilities of the plant."

The coal is carbonised in vertical iron tubular retorts, 9 ft. long and of average diameter of 5 in., the retorts being cast in groups of 12 assembled in a setting of 32 groups. The setting is heated by the gas made, and is equipped with closed chambers below the retorts to receive the coke after carbonisation, and allow it to cool without quenching and consequent contamination with moisture. Such a setting was designed to have a throughput of 50 tons of coal per day, and in the test, lasting two days, it was found that this claim was substantiated.

The coal employed was "Dalton Main," with which the Fuel Research Station had already considerable experience. It was a washed slack, fairly dry, containing 5 per cent. only of ash—a low figure for commercial supplies of coal. The yields of products per ton of coal as charged were :

Coke	13·92 cwt.
Gas	5620 cub. ft. or 39·6 therms.
Tar	18·62 gallons.
Crude Spirit (motor)	1·78 gall. yielding 1·39 gall. of refined product.
Liquor	26 gall., equivalent to 13·55 lb. of ammonium sulphate.

The coke produced, the report states, was of suitable size, not friable, contained little breeze, and only 4 per cent. of volatile matter. It successfully withstood an eight-day railway journey to the Fuel Research Station, was readily ignited in a household grate, and gave a good hot fire. It would appear, therefore, that the claim that the process produced a smokeless domestic fuel was substantiated. The analysis showing a volatile content of some 4 per cent. raises a doubt as to whether this fuel will develop the "cheerful blaze" which is so attractive to lovers of a coal fire, and contributes so much to speed of ignition.

The yield of tar was high, and chemically it was of the "low temperature" character. The yield of crude motor spirit was moderate, but the refining loss and consequent cost was considerable. The quantity of ammonia recovered per ton was good for low temperature practice, though low judged by existing carbonising practice, while the liquor obtained was so dilute that it is considered doubtful whether recovery was commercially justifiable.

The whole of the rich gas made was employed in heating the setting, supplemented by some producer gas specially generated. Compared with modern carbonising practice, this is a high fuel consumption, and it is pointed out in the report that a reduction could be effected by better design of the plant. The loss of this rich gas is more serious commercially, as the gas is the most valuable and least speculative

by-product of low temperature carbonisation. It may be assumed that the gas will eventually be put to some better use than heating the setting, for otherwise the financial burden of the process would have to be carried entirely by the coke and the tar and light oil—conditions which do not hold promise of smokeless fuel at a low price. As regards the economics of the process in general, though the report expresses no opinion, the data given as to plant and labour do not suggest low costs when compared with those of current carbonising practice.

The general impression which the report conveys is that the process yields a carbonised fuel regarded as meeting domestic requirements which will probably prove costly per ton, and the scope of the process will depend on whether the general public will be prepared to pay the price for such smokeless fuel in order to avoid the atmospheric pollution following the use of raw coal. H. J. H.

Applied Science at the University of Brussels.

THE highly successful celebrations in connexion with the fiftieth anniversary of the founding of the Applied Science School of the University of Brussels were held in the latter half of November, and were attended by the King of the Belgians, who received the foreign delegates, and also by the Duke of Brabant, who laid the foundation stone of a new building which will continue the development of the University. The city of Brussels and private donors have contributed largely to this scheme, as also the American Committee for the relief of Belgium. Great progress has been made in the buildings for pure and applied science at Solbosch, on the outskirts of Brussels, where, with ample space at disposal, it has been possible to erect a very fine block of buildings in the form of a hollow square.

Physics and chemistry are very well housed and equipped, and especial care has been taken to provide a number of small rooms for research work. The electrical engineering laboratories are remarkably well planned, and especially so as regards the arrangement of their numerous power circuits, which are carried round the walls below the windows and are protected by wire grillages. These circuits are connected to a number of panel units also completely enclosed and provided with the usual resistances, switch gear and measuring instruments all connected up in such a manner that students can readily trace out the various circuits, to which access is gained by numerous doors.

The main laboratory for investigating the strength and other physical properties of materials is chiefly notable for a fine equipment of Amsler testing machines housed in a spacious room provided with an overhead crane, and there are also a considerable number of accessory instruments for measurement and calibration work. A special photo-elastic laboratory is also arranged for in connexion with this department.

The laboratories for technical thermodynamics and hydraulics are now in course of equipment and are on a large scale typical of continental views of such matters, and, like the other laboratories, have well-lighted basements with considerable head room, an arrangement which is especially convenient for steam plants and machinery dealing with the flow of liquids.

In connexion with the celebrations, a number of scientific and technical addresses were given, and numerous other functions were arranged by the Government, the University, and the civic authorities. E. G. C.

University and Educational Intelligence.

ABERDEEN.—The University Court has appointed Dr. A. Bowman to the lectureship on the scientific study of fisheries, in succession to Dr. T. Wemyss Fulton, resigned.

Prof. A. Findlay has proceeded on leave of absence to the United States, where he will act as substitute professor of chemistry at Leland Stanford University for the next nine months.

CAMBRIDGE.—The report of the Botanic Garden Syndicate refers to continued financial anxiety despite the generous support of Mr. Reginald Cory. A prospective legacy from an old friend of the Garden is referred to in the report at her special request in order that it may stimulate others to follow her excellent example. In the recent death of Mr. R. I. Lynch, Curator of the Garden from 1879 until 1919, a link with the past has been snapped. One item of interest in the report is the exchange of shrubs from the Garden for birds from the Zoological Society of London, two pairs of mandarin ducks having been recently received.

The John Bernard Seely Prize, formerly given for an essay in aeronautics, is in future to be awarded to the candidate who does best in aeronautics in the Mechanical Sciences Tripos.

EDINBURGH.—Sir Richard Lodge, who has been Dean of the Faculty of Arts for thirteen years, has resigned this office, and the Faculty has elected Prof. E. T. Whittaker to succeed him as Dean. Prof. Hudson Beare and Prof. Lorrain Smith have been re-elected Deans of the Faculties of Science and Medicine respectively.

At its last meeting the University Court, on the recommendation of the Senatus, appointed Dr. Claude B. Ker, lecturer in infective fevers, to be a senior lecturer, with a seat on the Faculty of Medicine and on the Senatus, and Dr. E. M. Horsburgh, reader in technical mathematics, to be a member of the Senatus.

Dr. Douglas A. Allan, at present an assistant in the Department of Geology, has been appointed lecturer in geology in Armstrong College, University of Durham.

LONDON.—The following doctorates have been awarded:—*Ph.D.* (*Science*), Mr. R. E. W. Maddison (King's College) for a thesis entitled "Part I.: The action of light on chlorine water and aqueous hypochlorous acid solutions; Part II.: Retardation and acceleration of certain chemical reactions by light of different wave-lengths"; Sachindranath Sen (Imperial College—Royal College of Science) for a thesis entitled "On the design of the Kew pattern barometer."

WE learn from the *Chemiker Zeitung* that Prof. A. von Parseval has been nominated to the newly instituted chair of aviation at the Munich Technical Hochschule; and that Dr. Wilhelm Eitel, professor of physico-chemical mineralogy and petrography at Königsberg, has been invited to the chair of mineralogy at Freiburg-im-Breisgau.

APPLICATIONS are invited from medical graduates for the Marks lectureship in applied physiology and the Sheridan fellowship in the University of Adelaide. The applications, with testimonials, statement of academic qualifications, published researches, and a recent photograph, should be sent before the end of January, marked outside "Application for Marks Lectureship," to the Vice-Chancellor of the University, c/o the Agent-General for South Australia, Australia House, Strand, W.C.2.

FOLLOWING closely on the announcement of a gift by Mr. G. Eastman of about 3,000,000*l.* for educational purposes, which was referred to in this column last week, came a message from the New York correspondent of the *Times* announcing a further munificent gift to American education. It is stated that Mr. James B. Duke, who is connected with the tobacco and water-power industries, has created a trust fund of about 8,000,000*l.* for establishing a university in North Carolina which will bear his name. Should Trinity College at Durham in that State agree to change its name to Duke University, the trustees of the fund are authorised to expend 1,200,000*l.* in expanding and extending it, otherwise this sum will be used to start immediately the building of the new university. The trust provides that 20 per cent. of the income from the capital shall be withheld until an additional 8,000,000*l.* has been contributed from other sources. Other educational institutions, churches, hospitals, etc., in North and South Carolina will also benefit under the trust.

A PAMPHLET has been issued by the London County Council containing the lectures for teachers which have been arranged for the coming year. Some of the courses are repetitions of those given during the past term and announced in the handbook of lectures issued last August (see NATURE, August 30, p. 334). New courses include a series on some of the public services of London, each lecture of which is to be delivered by an authority. Among the lecturers are Mr. T. Hardie, of the Gas Light and Coke Co., on the manufacture and distribution of gas; Sir Alexander Houston, of the Metropolitan Water Board, on pure water supply; Mr. J. H. Rider, on electricity supply. Special single lectures will also be given by Mr. W. H. Barker and Prof. P. M. Roxby on problems of tropical Africa and the political geography of the Far East respectively, while Dr. Cyril Burt is to deliver two courses of five lectures each on sub- and super-normal children. Particulars of the lectures can be obtained from the County Hall, Westminster Bridge, London, S.E.1.

AT the annual meeting on November 20 of the Carnegie Corporation of New York, the president and treasurer presented reports, and a brief statement has been printed in *Science*. From this account it appears that the assets of the Corporation on October 1, 1923, were about 26,700,000*l.*; this sum constitutes two trusts for the advancement and diffusion of knowledge and understanding among the people of the United States and in Canada and other British Dominions respectively. During the past year about 2,600,000*l.* was paid out from the former trust and about 18,000*l.* from the latter. Noteworthy grants (approximately in pounds sterling) made during the year were as follows: Carnegie Institute of Pittsburgh, 3,265,000*l.* (the largest single grant made in the history of the Corporation); National Research Council and National Academy of Sciences, 1,000,000*l.*; educational institutions in Eastern Canada, 600,000*l.*; Institute of Economics, 330,000*l.*; Food Research Institute (Stanford University, California), 141,000*l.*; Johns Hopkins Medical School, 400,000*l.*; New York Academy of Medicine, 200,000*l.*; American Library Association, 37,000*l.*; Harvard University (for training personnel for museum service), 20,000*l.*; Institute of International Education, 36,000*l.*; Society for the Promotion of Engineering Education, 22,000*l.*; University of California (for the study of pyorrhea), 17,000*l.*; Union University (Albany Medical College), 10,000*l.*; various agencies for insulin research, 9000*l.*

Early Science at the Royal Society.

December 20, 1677. Mr. Oliver Hill read a written discourse of his, about the method which the Society ought to take in their proceedings, much different from what they then followed.

December 21, 1663. It was ordered that Dr. Merret and Dr. Whistler inquire of some members of the College of Physicians concerning the form of the warrant for bodies to be demanded from the sheriff of London for dissection, and make report thereof.

1664. There were read three several accounts of the comet lately seen, one by Sir Robert Moray, as he observed it December 17 at Whitehall; another sent from Portsmouth, as it was seen by the earl of Sandwich on board of the London at Spithead; a third sent from Ireland, as it was seen at Dublin by Mr. Kearney and another gentleman severally.

1671. Mr. Isaac Newton, professor of mathematics in the university of Cambridge, was proposed candidate by the lord bishop of Salisbury.

December 22, 1686. A paper of Dr. Papin about shooting a spherical bullet by exhausting the air out of the barrel was read, and the experiment shown: but by reason of the night the fall of the bullet could not be seen, and therefore the experiment was ordered to be made some other time [Earl of Carbery, president].—Mr. Hooke read his discourse concerning shells, etc., wherein he gave several material instances to prove, that there have been very great changes in the earth's surface, as of rows of oister shells found in a cliff in the Alps, sea-sand and shells at a great depth in St. James's fields, and the like shells observed by himself at a great hight from the sea, in a cliff in the Isle of Wight.

December 23, 1663. Occasion being given to discourse of tormenting a person with the sympathy-powder, Dr. Wren related, that in the house of a kinsman of his, the experiment had been tried by him upon a servant, who had grievously cut her finger; and a rag rubbed upon the wound being dressed with calcined vitriol, and put into the maid's bosom, her finger within a short time was cured. Whereupon he had taken the rag from her and heated it upon the fire, whilst the maid was sweeping the next chamber; who, upon a sudden, flung away the broom, and cried out for the pain in her finger; which being looked to was found very fiery: upon which they cooled the rag again, and dressed as formerly, and within a day or two the finger was intirely cured. Mr. Boyle undertook to try this experiment upon a dog.

December 24, 1662. Mr. Charles Howard was proposed candidate by Col. Tuke, and was presently chosen; his desire being to be rather admitted by scrutiny, than by the privilege of his birth.—Sir Robert Moray and Mr. Bruce made several relations of accidents which had happened in coal-mines; and were desired to give them in writing.

December 27, 1666. It was ordered, that the operator Richard Shortgrave, do for the future bring no bill of work done for the society without some avoucher, who shall be a curator of the respective experiments, about which he shall have been employed: and that without such avoucher, no account of the said operator shall pass in council: with which order he, being called was made acquainted. [This "operator" would appear to have acted as such for ten years, since at the expiration of that period, we read that it was ordered that "the apothecary's bill for the last sickness of the late Mr. Shortgrave be paid by the treasurer, his widow having first delivered up all the instruments, utensils, etc., belonging to the Society."]

Societies and Academies.

LONDON.

Royal Statistical Society, November 18.—G. Udny **Yule**: The growth of population and the factors which control it. Prof. Verhulst's law implies that the percentage rate of increase falls continuously, and in the simplest case is a linear function of the population at any moment. Verhulst's work fell into oblivion, but recently and independently has been suggested by Profs. Pearl and Reed. If a population unaffected by migration follows such a law of increase, it can only be by the death-rate rising, or the birth-rate falling, or generally by the death-rate rising continuously *relatively* to the birth-rate. The death-rate tends to increase with density of population, but in recent times in civilised States this tendency has been completely outweighed by the progress of medicine, and the death-rate has fallen rapidly in spite of great increases in population. This suggests that, in recent times at least, the birth-rate has been the controlling factor. If a population, subjected to constant death-rates at every age, grows in accordance with a law of the kind suggested, the death-rate tends continuously to increase—at first slowly, then more rapidly, and then slowly again—owing to the increase in the proportion of the old. The facts in general, in particular the very early stage at which the fall in the rate of increase becomes apparent, suggest that the growth of population is a biologically self-regulating process and that the regulation is highly sensitive. Malthus's conclusion that the checks to population may be fairly resolved into misery and vice is an exaggerated statement of the case.

Royal Microscopical Society, November 19.—G. R. **de Beer**: The histology of the pituitary body. The anterior lobe of the pituitary body has been known for some time to contain cells of two markedly different kinds, and the problem has not been solved as to whether these kinds represent distinct cell-types, or different stages of functional activity of one kind of cell. Critical fixation and staining with particular Romanowsky stains reveals the difference in staining-reaction between the two types of cells, and the interesting point that no intermediates appear, at least in the cat and the ox. Examination of the nuclei, the nature of the granular contents of those cells which can be proved to be active in secretion, and of the Golgi apparatus, reveals variability. The argument from comparison, however, and especially with the rabbit, where intermediates appear, and forms lower on the vertebrate scale of evolution, suggest that the latter of the alternative hypotheses is true. Critical methods emphasise the distinctness of the recently recognised pars tuberalis.—Miss J. **Latter**: Pollen development in *Lathyrus odoratus*. The resting nuclei of the pollen mother cells of *Lathyrus odoratus* exhibit a large nucleolus in which a crystalloid, probably of protein nature, is constantly present. The reticulum is of a very granular appearance, becoming definitely thread-like during synapsis. The post-synaptic thread at first lies in large irregular loops throughout the nuclear cavity, one loop always being connected with a deeply staining body in the nucleolus, possibly a modified form of the protein crystalloid. Seven loops of the thread persist, each comprising a pair of homologous chromosomes united end to end, and they radiate from the centre of the cavity. The name *broxonema* is given to this stage. The arms of the loop become intimately twisted round one another, thus affording opportunity for exchange of segments between the homologous chromosomes of a pair. This provides a possible physical basis for the phenomena of crossing over.—W. N. F. **Woodland**: Some remarkable caryophyllæids from siluroid fishes of the Sudan. Caryophyllæus is of special interest as being an example of a monozoan cestode. Until last year, less than a dozen species were known, all very similar to each other. The new caryophyllæids differ greatly from all those previously discovered and form a new genus Wenyonia. Wenyonia differs from Caryophyllæus in having the sexual apertures situated in the anterior half of the body, in the longitudinal extent of the uterus being as great or greater than that of the testes, in the vitellaria being medullary instead of cortical, and in some other respects.

Linnean Society, November 20.—H. A. **Baylis**: Cestodes from whales of the genus Balænoptera. The first form referred to was the recently described *Priapocephalus grandis* Nybelin, a tetrabothriid in which the typical suckers and auricular appendages of the scolex have disappeared, and the scolex has been modified into a bulbous "holdfast," which is buried in the lining of the host's intestine. Great similarity exists between the scolex of Tetrabothrius and that of Dinobothrium, a genus usually referred to a different group of cestodes, the Tetraphyllidea. It was suggested that, through such forms as these two genera, the Cyclophyllidea and Tetraphyllidea grade into each other.—J. R. **Norman**: Blind cave-fishes. The known forms now number about seventeen, to which may be added an undescribed blind catfish recently received by the British Museum (Nat. Hist.) from the Guacharo Caves, Trinidad. The cyprinodont family Amblyopsidæ contains eight species variously distributed in the United States, seven of which live permanently in subterranean waters, while one inhabits open streams. All have more or less degenerate eyes, which are merely vestigial in five species. In most of them sensory papillæ have been developed on the head and body to compensate for the loss of vision. The two blind fishes occurring in caves in Cuba belong to a marine family, the Brotulidæ. In both the eyes are vestigial and covered with skin in the adult, but small and well developed in the young. The head is provided with small tactile appendages. The remainder of the blind cave-fishes are all members of the order Ostariophysi, and occur in America and Africa. Two of them, belonging to the cyprinoid suborder, are related to the widely distributed genus Barbus; the remainder are allied to various members of the sub-order Siluroidea (catfishes). The eyes present varying degrees of degeneration, sometimes even in the same species, and accessory sensory organs are sometimes developed. The association of degenerate eyes with cavernicolous habits thus appears in several very different families and in many widely separated regions of the world.—G. H. **Stilwell** and H. **White**: *Pyrus lagenarius*. The tree was raised from seed gathered by E. H. Wilson for the Arnold Arboretum, in 1910, at Tachien-lu, in the Province of Sze-chuan near the Tibet frontier, at a height of between 5000 and 6000 feet. The original bush is now 9 feet high. The flowers are red and white. The leaves large, persisting on the ends of the shoots during the winter, and after a few years it fruits freely. The fruits become a beautiful golden-yellow by Christmas, and make a delicious jelly. It appears quite hardy in the South of England, and grows rapidly.

Physical Society, November 28.—Discussion, arranged jointly with the Royal Meteorological Society; Ionisation in the atmosphere, and its influence on the propagation of wireless signals.—W. H. **Eccles**:

A brief history of wireless telegraphy in relation to atmospherics, and an outline of the parts that may be assigned to diffraction, the Heaviside layer and ionic refraction is given. Certain facts, such as the errors of direction finding at night, and the success of long-distance transmission using short wave-lengths, offer confirmation of the hypothesis of an ionised layer in the upper atmosphere.—C. **Chree**: Atmospheric ionisation and its variations. For instantaneous values it suffices to know the potential gradient and either the conductivity or the vertical air-earth current; but in the case of mean values a knowledge of all three elements is necessary. Information as to diurnal variation is very scanty, except in the case of potential gradient. The monthly values in the annual variation, and the hourly values in the daily variation, are expressed as percentages of their arithmetic means. This is done partly because less uncertainty attaches to relative than to absolute values in the case of all the electrical elements. Reference is made to some conclusions as to the diurnal variation of potential gradient and the existence of a sun-spot period recently arrived at by Dr. Bauer and Dr. Mauchly, of the Carnegie Institution of Washington.—E. V. **Appleton**: Geophysical influences on the transmission of wireless waves. The variability of signals may sometimes be attributed to the varying phase and amplitude of rays ionically refracted by the upper atmosphere. The diurnal variation of such signals is described, and the strong night signals attributed to a lower atmosphere devoid of excessive ionisation. The facts of wireless telegraphy show that the atmosphere exerts a variable but usually favourable influence on wave propagation. This influence may be interpreted in terms of ionic refraction (Eccles), which, to prevent excessive dissipation, must take place at levels sufficiently high to make the mean free paths of the effective carriers large (Larmor).—R. A. Watson **Watt**: Atmospherics. The results of an examination of the meteorological conditions prevailing at apparent sources of atmospherics, as located by direction finding, show that, even with the limited data available, relations with thunderstorm phenomena, precipitation, or barometric minima have been traced in 87 per cent. of 490 cases, distributed over Europe, the Mediterranean, and North Africa. The tracing of a "cold front" for forty hours over 2000 km. across Western Europe, by directional recording of atmospherics, is reported. —C. T. R. **Wilson**: The electric field of a thunderstorm and some of its effects. A thundercloud may be pictured as having its upper and lower regions oppositely charged, the positive charge being most commonly on the lower side. The cloud lies at a moderate distance above the earth, while the Heaviside layer lies at possibly 100 km. above the earth. A lightning flash constitutes a short-circuit, in the absence of which the charges may leak away to the earth and the Heaviside layer respectively. Three possible causes of ionisation are suggested: (1) The charges on the cloud may ionise by induction at heights where the density of the air is very small. An ordinary cloud may have a sufficient electric moment to produce a similar effect, since this moment may be great even where the charges themselves are small, provided that the charges are separated by a great depth. (2) Beneath a thundercloud there is an intense potential gradient, producing a heavy earth-air current; the intensity of this current is hidden near the earth by the fact that part of it passes upwards through trees and the like. (3) The radio-active matter in the atmosphere produces β-particles, the energy of which, under the influence of the immense potential differences available, may be so great as to impart to the particles a kinetic mass equal to the mass of hydrogen atoms.—S. **Chapman**: The evidence of terrestrial magnetism for the existence of highly ionised regions in the upper atmosphere. Balfour Stewart's "atmospheric dynamo" theory of the daily magnetic variations is described; the earth's permanent magnetic field is the magnetic field of the dynamo; the atmosphere (undergoing small, but extensive, motions owing to thermal or tidal causes) is the moving armature; and particular ionised regions in the upper strata correspond to the "windings" in which the induced currents flow. The variations of ionisation are the chief cause of the changes of intensity in the diurnal magnetic variations, as between day and night, winter and summer, and sunspot minimum and sunspot maximum. Hence these changes in the magnetic variations indicate the changes in the ionisation of the atmospheric regions concerned. There seem to be two modes of ionisation, both due to the sun, and affecting different regions; one region, ionised by ultra-violet radiation, is a practically world-wide layer, possibly at about 50 kilometres above the surface; this is most intensely ionised directly under the sun in the sun-lit hemisphere, and the ionisation diminishes during the night. The other region consists of the polar caps within the auroral zones, and especially these zones themselves; this region is ionised by the impact of corpuscles emitted from disturbed regions on the sun's surface.

CAMBRIDGE.

Philosophical Society, November 24.—C. T. R. **Wilson**: The acceleration of β-particles in strong electric fields such as those of thunderclouds. An electric force of two-thirds of the sparking value is sufficient to give to a β-particle, travelling in air in the direction of the field with a velocity corresponding to 20,000 volts, additional energy which exceeds by the equivalent of about 10,000 volts the average rate of loss per cm. of air traversed. As the energy of the particle increases under the action of the accelerating field, the chance of survival of the particle increases, and the critical magnitude of the field required to produce a resultant gain of energy diminishes, reaching a limiting value for fast β-particles of about 1000 volts per cm. In the strong electric fields extending over great distances associated with thunderclouds, the energy acquired by β-particles may reach extremely high values, and X- or γ-radiation of correspondingly high frequency may be associated with them. Thunderclouds may thus be sources of "penetrating radiation."—G. F. C. **Searle**: The determination of the frequency of an alternating current supply by the vibration of rods.—F. W. **Aston**: Photographic plates for the detection of mass rays. The sensitivity of photographic plates to mass rays bears practically no relation to their sensitivity to light. The process of improving the qualities of the plates by "schumannising" is discussed and details are given of the procedure so far found most advantageous.—E. B. **Moullin**: On the current induced in a wireless telegraph receiving antenna.—R. R. S. **Cox**: Note on the chemical constant of chlorine.—L. **Bastings**: The decay constant of radium emanation. By comparing the activity of two nearly equal sources of radium emanation, first separately, and later together, with a standard radium source, by the aid of a simple β-ray electroscope, the decay constant of the emanation has been deduced, $\lambda = 0{\cdot}1808$ day^{-1}, or half-period $3{\cdot}833$ days, with an accuracy of at least 1 in 500.—E. L. **Davies** and G. N. **Livens**: The kinetic theory of metallic condition.

EDINBURGH.

Royal Society, November 24.—J. A. **Eldridge**: Note on Prof. Whittaker's atomic model.—J. **Tait** and W. F. **Emmons**: The mechanism of massive movement of the operculum of *Balanus nubilis*. The interest of this movement lies in the fact that, in its defensive reaction against any irritation caused by the lodging of an object on the opercular membrane, *Balanus nubilis* makes forceful rotatory movements of the operculum, the effect of which is to grind or crush the intruding object between the shell and the tergal plates. The pressure so exerted is very great, and yet there is no articulation of the operculum with the shell involving the contact of solid bearing surfaces. The forceful movement of the operculum with the strong lateral pressure which it can exert is due to two factors: (1) the horizontal component in the pull of the obliquely directed fibres of the powerful depressor muscles, and (2) hydrostatic pressure within the fold of the opercular membrane on the opposite side, the internal pressure being found to reach so much as 430 mm. of mercury.—T. J. **Jehu** and R. M. **Craig**: Geology of South Uist and Eriskay. The outstanding feature in the geology of the region is the great belt of crushed and sheared rock extending from north to south for a length of 22 miles along the mountainous eastern side of the island. The base of the belt is marked by an extraordinary development of flinty crush rock. This is succeeded to the east by sheared and crushed gneisses, mylonites, and highly mashed gneisses. The gneisses within the belt and west of it were originally of much the same characters and are all of igneous origin, belonging to the Archæan Complex. Dykes of later age include olivine dolerites, quartz dolerites, and lamprophyres. The ice flowing in from the Minch was to some extent deflected by the mountains on the east. The coastal features afford evidence of recent subsidence.—W. **Saddler**: The irreducible system of concomitants of two double binary (2, 1) forms. The problem of finding this system, which is theoretically known to exist, is here solved by Gordan's method of transvectants. Hitherto the only system for two or more given (m, n) forms which has been enumerated is the bilinear case when $m = n = 1$.—A. C. **Aitken**: A series formula for the roots of algebraic and transcendental equations. A series for symmetric functions of any number of the roots of an equation, of which Whittaker's series is a case.

SYDNEY.

Linnean Society of New South Wales, September 24.—Mr. R. H. Cambage, president, in the chair.—A. J. **Turner**: Revision of Australian Lepidoptera. Lasiocampidæ. The name Lymantriadæ is adopted instead of Liparidæ, on the ground that Liparis was preoccupied by Scopoli in the Pisces and cannot be used in the Lepidoptera. The Eupterotidæ, previously recognised as a separate family, are merged in the Bombycidæ. One new species of Lymantriadæ, one of Anthelidæ, one of Saturniadæ, and one of Notodontidæ are described. The natural position and classification of the Lasiocampidæ are discussed, and all the known Australian species, 54 in number and referred to 12 genera, are completely revised.—R. J. **Tillyard**: Upper Permian Coleoptera and a new order from the Belmont Beds, N.S.W. Six specimens of remains of insects from the Upper Permian of Belmont are Coleopterous elytra—four small ones which appear to be ancestral to the Upper Triassic Ademosyne and allies, one large one which is considered to be an ancestor of the existing Hydrophilidæ, and one which belongs to the order from which the Coleoptera arose, for which a new order is proposed, intermediate between the Carboniferous Protoblattoidea and the true Coleoptera. Two new families are described in the order Coleoptera, with two new genera and six new species.—John **Mitchell**: (1) A preliminary reference to a new species of Elonichthys from the lower beds of the Newcastle Coal Measures. (2) Further reference to the occurrence of *Merista plebeia* Sowerby in New South Wales. (3) Eleven new species of Aviculopecten from Carboniferous rocks, Myall Lakes, N.S.W. These form an interesting addition to those already recorded from the Carboniferous and Permo-Carboniferous rocks of Australia. Their occurrence, unaccompanied by a single species known from rocks of similar age elsewhere, is of interest.

Royal Society of New South Wales, October 1.—Dr. C. Anderson, president, in the chair.—M. B. **Welch**: Note on the structure of some Eucalyptus woods. An anatomical investigation of the structure of Eucalyptus timbers may enable these woods, which often resemble each other closely, to be identified with greater accuracy. Thus there is a much greater development of parenchymatous tissue in what are regarded as the more primitive Eucalypts. The species specially dealt with are *E. maculata*, Hook., *E. pilularis*, Sm., and *E. microcorys*, F. v. M. In the latter, numerous oil globules occur, principally in the medullary rays. The presence or absence of tannin, the form of the rays, and the arrangement of the wood parenchyma are valuable diagnostic characters.—W. A. W. **de Beuzeville** and M. B. **Welch**: A description of a new species of Eucalyptus from southern New South Wales. The new Eucalypt was found at an elevation of 4000 feet on the Main Dividing Range, in the vicinity of the Big Badja Mountain. The bark is characterised by the presence of large groups of oil glands, which measure up to 0·25 mm. in diameter.—A. R. **Penfold**: The essential oils of *Melaleuca erubescens* (Otto) and *M. hypericifolia* (Smith). The former is a heath-like shrub with reddish purple flowers, whilst the latter is a handsome shrub with beautiful crimson bottle-brush flowers, and both occur in New South Wales. They both yielded pale lemon-yellow oils much resembling those of Eucalyptus, and were found to contain cineol, a-pinene, dipentene, limonene, a-terpineol, sesquiterpene, etc. *M. hypericifolia* yields the lowest quantity of oil and lowest percentage of cineol when growing near the coast in exposed positions, and the maximum yield of oil and cineol when obtained from moist rocky situations on the mountain ranges.—W. R. **Brown** and W. S. **Dun**: The stratigraphy of the basal portion of the Permo-Carboniferous system in the Hunter River Valley. The discovery of a fossil identified as *Eurydesma hobartense* in mudstones at the top of the Lochinvar shale indicates definitely that this must be regarded as the basal member of the Lower Marine division of the Permo-Carboniferous strata in the Hunter Valley, as originally suggested by Prof. David.—E. **Cheel**: Notes on Melaleuca, with descriptions of two new species and a new variety. Four of the species somewhat resemble the common Swamp Tea-tree (*Melaleuca ericifolia*) and have been previously confused with it, but certain structural characters, the geographical distribution, and chemical evidence distinguish them. A species somewhat resembling a Mountain Bottle-brush is described as a new species. It is fairly plentiful in the south coast districts of New South Wales. A new variety is also described from the Port Jackson district, having been found to have distinctive characters from the plants originally found in Tasmania. A species from the northern parts of the

State is also raised to specific rank, as it has very different characters from the Toad-flax-leaved Tea-tree with which is has previously been confused.

VIENNA.

Academy of Sciences, October 23.—K. **Stosius** and E. **Philippi**: On the action of ammonia on the esters of citraconic acid, mesaconic acid, and itaconic acid.—A. **Kailan**: On the chemical effects of penetrating radium radiation on potassium bichromate, potassium chromate, and potassium permanganate.—H. **Handel-Mazzetti**: Descriptions of new Chinese plants in the genera Carpinus, Podophyllum, Ehretia, Microcaryum, Trigonotis, Onosma, Ceropegia, Pentasacme.—L. **Abolin**: The influence of chemicals on colour change in fish. The action of infundin and adrenalin on the melano- and xantho-phores of the minnow Phoxinus. The assumption of male erythro-phore colouring by females treated with infundin.—V. F. **Brotherus**: New Chinese mosses from the Handel-Mazzetti expedition.

November 6.—Molecular compounds of phenols. IV.—G. **Weissenberger**, F. **Schuster**, and K. **Schuler**: The behaviour of binary systems with phenol and phenol-ethers. V.—G. **Weissenberger** and F. **Schuster**: Vapour pressure curves.

WASHINGTON.

National Academy of Sciences (Proc. Vol. 10, No. 10, October).—P. W. **Bridgman**: Some properties of single metal crystals. Crystals of zinc, cadmium, bismuth, antimony, tellurium, and tin were examined. Some interesting results are as follows: zinc, linear compressibility is nearly seven times as great parallel to the rotational axis as perpendicular to it, and electrical resistance decreases under pressure. Tellurium, linear compressibility parallel to, and thermal expansion along, the axis are negative. Electrical resistance, except for antimony, is greatest across the plane of easiest cleavage or slip. Cadmium forms two polymorphic forms at 20° C. under pressures of 3000 and 6000 kg./cm.^{2}—A. A. **Noyes** and H. W. **Estill**: Effect of insulin on the lactic fermentation. Insulin increases by 20-25 per cent. the amount of acid produced from glucose by *Lactobacillus bulgaricus*. It is hoped that work on these lines will aid in standardising insulin preparations.—M. T. **Bogert** and M. **Chertcoff**: A new group of dyes from poison gases through the 2-aminothiazoles as intermediates. The preparation of thiazole dyes of Doebner violet type. These substances dye silk, wool, and mordanted cotton a green tint similar to malachite green, but bluer and more dull. They are fugitive in direct sunlight. The poison gases used were dichloro ether, chloroacetone, and chloroacetophenone.—M. T. **Bogert** and P. S. **Nisson**: (1) The synthesis of terephthal green and terephthal brilliant green from cymene. These new dyes, compared with malachite and brilliant green (triphenylmethane derivatives), dye wool and silk a yellower green. They compare favourably in tinctorial power and fastness. (2) Further experiments in the field of the terephthalic acid derivatives.—E. B. **Wilson** and W. J. **Luyten**: A statistical discussion of sets of precise astronomical measurements (IV.); the mass-ratio in binaries. The apparent clustering of mass-ratios about unity is probably due to observational selection; the actual association may not be materially different from random mating.—H. **Shapley**: Note on the thermokinetics of dolichoderine ants. The speed of ants varies with changes of temperature. When the temperature was under control, maximum speed was attained by one species of ant, Tapinoma, at 36° C. Through a limited range of temperature, the speed-temperature ratio is constant.

Official Publications Received.

The North Staffordshire Field Club. Transactions and Annual Repor 1923-24. Edited by S. A. H. Burne. Vol. 58. Pp. 157+41-66+7 (Stafford.) 7*s.* 6*d.*

Society for the Provision of Birth Control Clinics. First Annual Repo of the Walworth Women's Welfare Centre, 1924. Pp. 16. (London: 13 East Street, S.E.17.)

Memoirs of the Asiatic Society of Bengal. Vol. 8, No. 3: The Boats the Ganges, by James Hornell; The Fishing Methods of the Ganges, James Hornell. Pp. 171-238. (Calcutta.) 2.13 rupees.

The South-Eastern Naturalist: being the Twenty-ninth Volume Transactions of the South-Eastern Union of Scientific Societies, includi the Proceedings at the Twenty-ninth Annual Congress, held at Guildfor 1924. Edited by Edward A. Martin. Pp. lxxxvii+99. (Londo 5*s.* net.

British Honduras. Annual Report of the Forest Department for t Year ending 31st March 1924. Compiled by C. L. Stocker. Pp. 18+ map. (London: Crown Agents for the Colonies.)

Department of the Interior: Bureau of Education. Bulletin, 192 No. 5: The Chief State School Official. By Prof. Ward G. Reeder. P iv+67. Bulletin 1924, No. 9: Intelligence of Seniors in the High Schoo of Massachusetts. By Stephen S. Colvin and Andrew H. MacPha Pp. vi+39. Bulletin, 1924, No. 16: Objectives in Commercial Enginee ing; Report of the Second Conference on Business Training for Enginee and Engineering Training for Students of Business, Pittsburg Pennsylvania, May 1 and 2, 1922. Prepared by Glen Levin Swigget Pp. iii+66. (Washington: Government Printing Office.) 10 cents eac

The National Physical Laboratory, Teddington, Middlesex: Metrolo Department. Gauge Testing. Pp. 39. (Teddington.)

The University of Manchester: the Manchester Museum. Museu Publication 88: Report of the Museum Committee for the Year 1923-2 Pp. 20. (Manchester: Manchester University Press; London: Longman Green and Co.) 6*d.* net.

The Manchester Museum: Museum Handbooks. Publication 8 Outline Classification of the Animal Kingdom. By Prof. Sydney Hickson. Fifth edition. Pp. 28 (interleaved). (Manchester: Manchest University Press; London: Longmans, Green and Co.) 6*d.*

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, N 29: Notes on Fossil Plants from the Old Red Sandstone of Scotlan II.: Nematophyton Forfarense, Kidston sp.; III.: On two Species Pachytheca (P. media and P. fasciculata) based on the Characters the Algal Filaments. By Dr. R. Kidston and Dr. W. H. Lang. P 603-614+2 plates. (Edinburgh: R. Grant and Son; London: Willian and Norgate, Ltd.) 2*s.* 6*d.*

Journal of the Marine Biological Association of the United Kingdo New Series, Vol. 13, No. 2, November. Pp. 319-530. (Plymouth 7*s.* net.

Publication de la Commission Géodésique Néerlandaise (Uitgegeve door de Rijkscommissie voor Graadmeting en Waterpassing). Obse vations de Pendule sur la mer pendant un voyage en sous-marin Hollande à Java, 1923. Par Dr. F. A. Vening Meinesz. Pp. iii+1 (Delft: Boekhandel J. Waltman, Jr.)

Smithsonian Miscellaneous Collections. Vol. 76, No. 12: "Adapt tions" to Social Life; the Termites (Isoptera). By Dr. Thomas Snyder. (Publication 2786.) Pp. 14+3 plates. Vol. 76, No. 13: Pr liminary Archeological Explorations at Weeden Island, Florida. By Walter Fewkes. (Publication 2787.) Pp. 26+21 plates. (Washingto Smithsonian Institution.)

Department of the Interior: Bureau of Education. Suggestions f the Observance of American Education Week, November 17-23, 192 Pp. 36. (Washington: Government Printing Office.) 5 cents.

Department of the Interior: United States Geological Survey. Pr fessional Paper 127: The Composition of the Earth's Crust. By Fran Wigglesworth Clarke and Henry Stephens Washington. Pp. v+11 (Washington: Government Printing Office.) 20 cents.

Sixty-second Annual Report of the Secretary of the State Board Agriculture of the State of Michigan, and Thirty-sixth Annual Repo of the Experiment Station from July 1, 1922, to June 30, 1923. Pp. 50 (East Lansing.)

Annual Report of the Board of Regents of the Smithsonian Institutio showing the Operations, Expenditures, and Condition of the Institutio for the Year ending June 30, 1922. (Publication 2724.) Pp. xii+554+14 plates. (Washington: Government Printing Office.) 1.50 dollars.

Department of the Interior: United States Geological Survey. Miner Resources of the United States, 1915. Part 1: Metals. Pp. iv+99A-1000+3 plates. Mineral Resources of the United States, 1916. Part 1 Metals. Pp. v+73A+871+3 plates. Part 2: Nonmetals. Pp. v+111 +4 plates. Mineral Resources of the United States, 1917. Part 1 Metals. Pp. v+79A+980+8 plates. Part 2: Nonmetals. Pp. vi+129 +1 plate. Mineral Resources of the United States, 1918. Part 1: Metal Pp. iv+149A+1096+9 plates. Part 2: Nonmetals. Pp. viii+1557+1 plates. (Washington: Government Printing Office.)

Proceedings of the Liverpool Geological Society. Session the Sixty fifth, 1923-1924. Part 1, Vol. 14. Edited by C. B. Travis. Pp. xx+98+ plates. (Liverpool.) 5*s.*

Diary of Societies.

TUESDAY, DECEMBER 23.

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at 83 Pa Mall), at 6.30.—Demonstration and Discussion on Anti-dazzle Devices.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Grey Street, Hull), 7.45.—A. E. Butterfield: The Development of Unattended Navigatio Lights.

SATURDAY, DECEMBER 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Co cerning the Habits of Insects (I.). Insect Collecting and what leads to.

NATURE

SATURDAY, DECEMBER 27, 1924.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2878, VOL. 114]

Twentieth-Century Universities of England.

"ENGLAND, which till lately has had but two universities in the proper sense of the word, will have a dozen, and perhaps the United Kingdom will have a score." So prophesied Sir John Seeley in 1887. By 1909 this forecast had been proved approximately correct: the realisation of projects now pending for raising the University Colleges of Nottingham and Reading to the status of full universities would complete its fulfilment exactly. At present England has ten universities, all of which, except Oxford, Cambridge, and London, were constituted in the first ten years of this century—thirty years after the decade (1871–81) within which were founded nearly all the colleges in which they had their origin.

The first year of the twentieth century saw the granting of a charter to the University of Birmingham (the pioneer in England of the unitary teaching or "single college" type) as the result of zealous and persistent efforts on the part of a group of progressive educational politicians under the leadership of Mr. Joseph Chamberlain. In 1903 the Universities of Manchester and Liverpool, and in 1904, Leeds, received their charters, superseding the charter of 1880 by which the Victoria University was founded as a federal institution. Ten years later, Lord Haldane said of the Order in Council consenting to the charters for Manchester and Liverpool: "The date of this order is, I think, a memorable one. It gave State recognition to a new policy. . . . The principle was accepted that the number of the English Universities was to be increased, and their headquarters were to be in cities." Next came the University of Sheffield, in 1905. In 1908 a charter was granted under which the University of Durham, founded in 1832 under ecclesiastical auspices, was reconstituted as a federal university, with a Newcastle division consisting of the College of Medicine and Armstrong College. The youngest of this family of seven is Bristol, which received its charter in 1909.

This remarkable activity in university-making is attributable in no small measure, as Prof. Newton has lately pointed out,[1] to the discussions which preceded the reconstitution in 1900 of the University of London, consolidating, as they did, public opinion as to what a modern university should be, and stimulating the desire of the provincial university colleges to achieve full autonomy. Dr. A. C. Headlam's interpretation of this opinion may be usefully compared with Seeley's pronouncement a generation before. "A University," wrote Dr. Headlam in "Universities and the Empire," "ought to be an autonomous self-governing corporation, with a constitution of such a character that the influence of broad-minded learning may be supreme.

[1] "The Universities and Educational Systems of the Empire" (Collins, 1924).

Its aim should be *the creation of intellectual life* and the promotion of the highest form of teaching, side by side with original research and investigation." Seeley, in the course of an address delivered in the Town Hall, Birmingham, in 1887, said: "Modern civilisation needs a vast quantity of science: the demand for trustworthy knowledge, scientific, sanitary, technical, economical, political, historical, moral and religious, rises with urgency from these great towns. . . . It is a demand for knowledge, not for training. It is not made in the interest of the young. It calls for institutions by which the whole science of the age may be brought within the reach of all, young and old alike; in short, it calls not for new schools or new colleges in the Oxford and Cambridge sense, but, in the strictest sense of the word, for new universities." Generous as were Seeley's aspirations, the italicised words in the quotation from Dr. Headlam (not italicised in the original) indicate a notable advance since Seeley's day in current conceptions of the functions of a university. We can now say that the discovery of new knowledge and the extension of intellectual fields which follows from it, are an essential part of university life in all departments.

If one looks back to the circumstances of the foundation of the colleges in which the twentieth-century universities originated, one is struck by the fact that they began in most cases as science colleges. Armstrong College, Newcastle-on-Tyne (incorporated in the University of Durham in 1908), was founded in 1871 as the Durham College of Physical Science. Yorkshire College, destined thirty years later to become the University of Leeds, was established as a College of Science in 1874. University College, Bristol, began as a College of Arts in 1876, but the Merchant Venturers' Technical College was associated with it in 1876, and rapidly developed. In 1879 and the following year respectively were founded, as Science Colleges, Firth College, Sheffield, and Mason College, Birmingham. Lastly, in 1881, University College, Nottingham, was opened as a science college, and University College, Liverpool, obtained its charter.

Of the various movements and events which contributed to the establishment of these University Colleges in such rapid succession, and gave them so marked a bias on the side of science and technology, much was said in the course of the jubilee celebrations which took place at the University of Leeds last week. Among them may be mentioned: the Mechanics' Institutes movement, which attempted to stimulate and satisfy the desire of industrial workers for a knowledge of the great discoveries of science, the progress of these discoveries and the rapid development of their applications to industry, the consequent inadequacy of the apprenticeship system of training engineers; the Women's Emancipation movement; the University Extension movement, the Exhibition of 1851 and, perhaps still more, the Paris Exhibition of 1867; the Elementary Education Act of 1870; the Schools Enquiry Commission, and the Royal Commissions on the Universities of Oxford and Cambridge. One of the most powerful of the motives influencing leaders of public opinion at the time was that of providing scientific teaching for students in manufacturing towns, in order to enable England "to maintain her position as the manufacturing centre of the world."

We should be sorry, however, to suggest that the claims of science in education must be presented to an educated community purely on utilitarian grounds. Few scientific workers would now advance that view, and most would agree that in university work the spirit of research should be that of the pursuit of knowledge for its own sake rather than for the profit to be gained from it. The principles upon which the chief modern industries are founded, and the elements used for various purposes in manufacture, were almost all first discovered by investigators working in university and other laboratories without any motive of industrial application before them. It is remarkable to note, for example, that not a single chemical element has ever been discovered in an industrial laboratory, and that the rare elements which are now of such importance in modern developments would never have been thought worth consideration as a means of making profit in a manufacturing works.

Lord Balfour referred very definitely to these aspects of science in a university in an eloquent speech on December 15 at Leeds in connexion with the university celebrations there. "Science itself," he said, "cannot be pursued effectively in the spirit of wealth acquisition. To have applied science you must have pure science, and you will never get pure science to be what it might be, or knowledge really furthered effectively, until those who try to further it are animated in the main, not by material gains, but by the joy of augmenting knowledge itself."

With a right balance maintained between pure and applied science at universities, there must also be something beyond mere technical efficiency in either, namely, regard for the humanistic aspects of all studies. The new humanism of modern science should not permit itself to be strangled by the cordage of over-specialisation as has been the old humanism of classical learning; and if scientific studies are to exert their full influence upon our generation, students of them must be more than experts in their particular subjects—they must be human and social as well. Where this spirit is combined with rich knowledge and the desire to increase it, university training represents intellectual life at its highest and best.

"Elephants in American Art."

Elephants and Ethnologists. By G. Elliot Smith. Pp. viii + 135 + 52 plates. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1924.) 15*s.* net.

IN the book which is before us Prof. Elliot Smith has reverted to a subject upon which he enlarged in NATURE some years ago (1915–16). By bringing together under one cover the full evidence upon which he relies in his argument, he has endeavoured once for all to dispose of what he calls the "stereotyped form of criticism," and finally to defeat those who do not endorse his views as to the Asiatic origin of certain items in the culture of Central America. He has succeeded in producing a readable and interesting treatise which is focussed upon a special feature in the art of Copan, and he offers this confidently as a test case in support of his major and more generalised theory. His argument is developed with skill, and he uses all his power as an advocate. But his handling of a much-debated and still debatable problem is, unfortunately, marred by frequent reliance upon dogmatic assertion. The Bellman's axiom, "What I say three times is true," may serve to limit discussion during a Snark-hunting expedition, but is unlikely to be accepted as finally convincing in scientific debate, and serves rather to stimulate than to allay criticism. Prof. Elliot Smith's doctrine would have gained strength, and possibly adherents, had he urged it less aggressively and devoted himself to the elimination of inconsistencies and to the more careful analysis of the evidence upon which he relies. His constant assertion that the case is proved, seems to suggest that further argument is needless. In spite of that, after reading carefully his in many ways able "discussion on one sharply defined issue," one still feels that scientific proof of the main hypothesis is yet to be found and that the problem remains unsolved.

The main discussion centres upon certain zoomorphic designs carved in relief upon the famous "Stela B" at Copan in Honduras, designs which Prof. Elliot Smith asserts represent the heads of Indian elephants, and cannot reasonably be mistaken for anything else (Fig. 1). Others have urged that these conventionalised animal themes have been derived from earlier attempts to represent *indigenous* faunal types, *e.g.* the macaw, the tapir, etc.; while, quite recently, Dr. H. O. Forbes has forcibly urged that the animal fancifully rendered is a cephalopod of some sort, possibly modified through fusion of this *motif* with the macaw theme.

FIG. 1.—Zoomorphic designs sculptured on "Stela B," Copan, Honduras. (After Maudslay.) From "Elephants and Ethnologists."

To Prof. Elliot Smith the design in question represents an "unmistakable Indian elephant ridden by an equally characteristic turbaned *mahout*" (p. 5). This being stated as a fact should end the discussion; but several points of importance call for further inquiry. Prof. Elliot Smith himself allows that the artist, in his attempt to portray an "elephant," was "unacquainted with the features of a living elephant" and "has mistaken its eye for the nostril and its ear for the

eye"; and he endeavours to explain away certain other features which are inconsistent with realistic rendering; and further (p. 112) he refers to "the remarkable modifications effected in the form of the creature when the conventionalised picture is transferred to regions where the animal itself is unknown." And yet, on p. 89, in referring to the Copan "elephants," he indulges in the description "so exact a representation of an animal . . ."—a palpable overstatement.

The author lays considerable stress upon certain details of the "elephant" design. He says, for example, "The external ear (pinna) is also accurate as to size and shape" (p. 7); but this fidelity to actual shape is by no means clear, and the form of this feature actually varies in the four representations of it (Fig. 1, A, B, C, and D), rendering the term "accurate" a somewhat elastic euphemism. He also refers (p. 7) to the position of the tusk as helping to reveal the animal's "identity as an Indian elephant." But where is the "tusk" in the Copan sculptures? Are we to recognise it in the upper one of the pair of patches of cross-hatched lines which occur on each side of the "trunk"? The markedly reversed curve of its outline seems to militate against this; and, moreover, it becomes difficult to diagnose the lower, *practically identical* patch, which cannot well be another tusk arising half-way down the trunk. The treatment of the "under surface of the trunk" is also urged in support of the author's identification. Does this refer to the lower reduplication of the "tusk" pattern? If so, its severe zonal restriction seems to involve a still further departure from realism.

In regard to the figure of the so-called "*mahout*," one requires some corroboration of the bare statement that this is a "characteristic turbaned *mahout*." The attitude of the figure scarcely reminds one of that usually assumed by *mahouts*; it may also be questioned whether the "turban" can rightly be designated by that specific term at all; and it would have been of interest if Prof. Elliot Smith had given his reasons for assuming that the "elephant goad" (even supposing that it is correctly rendered in the pictorial reproductions of the stela) bears any real resemblance to known forms of that instrument (Fig. 1, B).

On p. 27, in his criticism of Maudslay's suggestion that the animal represented is probably a tapir (a beast with which the Maya people were familiar), Prof. Elliot Smith says, "Nor again is it credible that a craftsman so highly skilled in modelling (as the artist who fashioned this stela must have been) could have made so indifferent a portrait of a tapir as this." But it must be borne in mind that this craftsman's skill was largely applied to the production of a decorative and symbolic design, and that when symbolism is subjected to decorative embellishment, there is no limit to the conventionalisation of even a perfectly *well-known* animal form. The treatment in art of the Rhinoceros Hornbill in Borneo, and of the Wreathed Hornbill in New Ireland, affords good examples of grotesque and unrealistic elaboration of familiar bird-forms; while the zoomorphic designs in the composite totemistic art of N.W. America, or the highly conventionalised renderings of the human form in New Zealand, the Hawaiian Islands, and elsewhere, illustrate the play of fancy in what might have been realistic art, since the true forms were familiar enough and the craftsmanship was of a high order.

It seems probable that the so-called "elephant" figures on stela B are designs which are not only symbolic and decorative, but have been arrived at by a fusion of attributes derived from different prototypes. Earlier representations of macaws, cephalopods, tapirs, or other indigenous animals may well have contributed elements in the evolution of this complex hybrid design. Such examples of composite themes are very frequent in zoomorphic and other art designs, and the results are often as striking and unexpected as is the superficial resemblance to an elephant noticed in the Copan carvings. Once the departure from realism has reached a fairly advanced stage, the process of conventionalisation would tend to become accelerated, and the original prototype or prototypes may rapidly become almost unrecognisable. Moreover, the great exaggeration of some special feature in a once more or less realistic design, with a correlated diminution and obscuring of other features, is a common result of elaboration for decorative purposes. The semblance of an elephant's trunk, for example, might easily arise from some hypertrophied portion of a totally different zoomorphic *motif*.

What is needed before a final diagnosis of these Copan carvings can be arrived at, is an intensive comparative study of the art of the Mayas, and a collation of all those designs which appear to be related to the "elephant" figures. In this way the true affinities of the latter might be established through linked series of variations. Until this can be done, the real genesis and evolution of the "elephant" designs in the New World will remain obscure and debatable. In the long run, possibly, Prof. Elliot Smith's hypothesis may prove to be justified, but that stage has by no means yet been reached, and, in spite of his confident and over-emphatic assertions, his case cannot be accepted as proven. In the meantime he has furnished a treatise which conveys a direct challenge, and has brought together and, in his own way, ably urged a mass of evidence in support of his diagnosis.

The book is worthy of serious consideration as a contribution to a debate upon a complex subject. Although in many ways attractive and stimulating, the volume shows evidence (in misprints, premature assumptions, and other blemishes) of having been produced hastily and under the influence of a dominating theory, which has militated somewhat against calmly critical and unbiassed treatment of the theme. The illustrations are numerous and for the most part clear, and the details which have been brought together and have been marshalled with debating skill will prove of much value in the further investigation of an interesting problem, which must still be regarded as in a "fluid" state.

Studies in Engineering History.

The Newcomen Society for the Study of the History of Engineering and Technology. Transactions, vol. 3, 1922–1923. Pp. xii+140+21 plates. (London: Science Museum, South Kensington, 1924.) 20*s*.

THE new volume of the Transactions of the Newcomen Society fully maintains the high standard reached in the two previous volumes. As studies in engineering history, the various contributions shed new light on matters of importance in industrial history, while the range of subjects treated will make a wide appeal. The principal contents of this volume consist of six papers read before the Society. The first of these is a sketch of the work of Simon Goodrich, who for many years held an important post as the mechanical engineer of H.M. Dockyard, Portsmouth. Making use of a mass of material deposited at the Science Museum nearly fifty years ago, Mr. Forward traces the connexion of Goodrich with Sir Samuel Bentham, the elder Brunel, Henry Maudslay, and other engineers of the time. Goodrich was assistant to Bentham in 1799 when the first steam engine at Portsmouth was installed for pumping at the docks. He also supervised the erection of Brunel's famous block-making machinery made by Maudslay and brought into use a short time before the battle of Trafalgar. The Navy at that time wanted more than 100,000 blocks a year. So far Mr. Forward has only given us the career of Goodrich up to 1805, but as he held office until 1831 the remaining documents should bring to light much of very great interest.

Mr. Rhys Jenkins has already contributed to the Transactions a paper on the iron industry, and we now have a sketch of the early history of steel-making in England. The period covered is roughly 1500 to 1750, that is, until about the time Huntsman introduced the manufacture of cast steel. Mr. Jenkins's researches have had very fruitful results, for he is able to show that the cementation process originated in England about the beginning of the seventeenth century. As the president of the Society remarked in the discussion, "it was flattering to think that, to the puddling and the Bessemer process they might now add the cementation process as being of English origin." As an appendix to his paper the author gives some transcripts from some books of accounts relating to the iron and steel works of Sir Henry Sidney in Sussex and Kent in the sixteenth century.

The three succeeding papers refer to widely different matters. Mr. Titley gives what might almost be called "The Natural History of the Windmill"; Mr. G. P. Baker is the author of a paper on Indian cotton prints and paintings of the seventeenth and eighteenth centuries, while Mr. Brownlie gives a striking review of the early history of the manufacture of coal gas. The industry, which had its birth in a small house in Redruth, has now grown into a key industry employing more than 150,000 men. Mr. Brownlie tells us that the first gas water-heater was made so long ago as 1825, and the gas stove was patented by Edwards in 1849. Modern developments of these most useful appliances date, however, from about 1890.

The last of the papers is by Mr. J. E. Hodgson on "Sir George Cayley as a Pioneer of Aeronautics." Though Cayley's name does not appear in the "Dictionary of National Biography," he must not be classed among the forgotten worthies. He was a country gentleman of the North Riding of Yorkshire, where he was born in 1773 and where he died in 1857. A man of the type of Edmund Cartwright, his claim to fame rests on his writings and experiments on mechanical flight and navigable balloons. Mr. Orville Wright indeed says that Cayley's articles in *Nicholson's Journal* of 1809–10 "show an understanding of the subject of aerodynamics hardly exceeded by any one except Lilienthal during the rest of the century." When Henson proposed in 1843 to construct an aeroplane of 150 feet span, it was Cayley who suggested that a better design would be to use three superimposed planes of far less span. Cayley's ideas regarding airships were also sound.

Besides these papers the volume under notice has a report of Sir Frank Baines's lecture to the Society on the preservation of historic buildings, and an account of Savery's work on the steam engine, by Mr. Jenkyns, being an amplified reprint of a paper contributed some years ago to the Devonshire Association; and also an hitherto unpublished letter from Faraday to Ampère preserved in the Staatsbibliothek at Berlin. The letter is dated 1821, the year Faraday made his memorable discovery of electro-magnetic rotation.

Huia Onslow's Life and Work.

Huia Onslow: a Memoir. By Muriel Onslow. Pp. viii+247+5 plates. (London: E. Arnold and Co., 1924.) 12*s.* 6*d.* net.

IN the columns of NATURE Prof. R. C. Punnett wrote of Huia Onslow after his death in 1922 that his life "was the wonder of those who knew him," and of his achievement that, fine as it was, "finer still was the way in which it was won." This volume tells of the achievement and gives an indirect but none the less true and moving picture of the life.

The account of Onslow's scientific work is clear and simple. He obtained notable results in several branches of science. In genetics he studied the inheritance of coat-colour in rabbits and mice, with particular reference to the microscopic distribution of pigment granules and to the phenomena of albinism. He also carried out a long series of investigations into the inheritance of wing-colour in Lepidoptera, more especially the heredity of melanism in a number of species of moths. He gave much time to the study of the brilliant iridescent colours of some insects, discovering, by means of an exceptionally careful microscopic technique, the existence of thin films of chitin over certain butterfly scales, either lying flat on one another (like the skins of an onion) or set on edge (like the ridges of a ploughed field). The iridescence of these scales was shown to be due to the interference effects of the thin films of chitin and air, and the colour could be abolished by immersing the scales in liquid of the same refractive index as chitin, so that the air was expelled. In iridescent beetles no such structures could be found, and Onslow concluded for various reasons that a thin film of substance showing selective metallic reflection was responsible for the colours.

Turning to another branch of knowledge, Onslow was jointly responsible (with S. W. Cole) for the working out during the War of a standard nutrient medium for bacteriological purposes, now widely used, and of a method for the differentiation of typhoid and paratyphoid strains. He was also interested in protein chemistry, and was successful in solving the difficult problem of the quantitative estimation of the amino-acid tryptophane in casein.

Perhaps the most significant of Onslow's researches were those in what must eventually prove a fruitful field—the borderland between biochemistry and genetics, where he was a pioneer. Here undoubtedly his thorough and patient investigation would have yielded triumphs had he lived longer, and here especially it is to be hoped that his lead may be followed and his results extended.

One line of investigation concerned the chemistry of coat-colour in rabbits, more especially of dominant and recessive whiteness. It had been suggested that the melanin pigments present in hair were formed by the oxidation of the amino-acid tyrosine through the action of the enzyme tyrosinase. Onslow showed that extracts from the skins of coloured rabbits contain tyrosinase and form pigment when mixed with a solution of tyrosine, while extracts from the skins of albino rabbits (recessive white) do not form pigment from tyrosine. Albinism would thus appear to be due in this case to the absence of tyrosinase. In rabbits carrying a dominant factor for whiteness, on the other hand, extracts of the skin contain a substance which inhibits the production of pigment from tyrosine by extracts from coloured skins. The foundation of a genuine chemical explanation of one phenomenon of Mendelian heredity was thus established.

Again, Onslow found that the production of melanin in the black markings on the wings of the Cabbage White butterfly had a similar cause. There is no black pigment in the pupal stage; when there is access to the air, tyrosine is oxidised to melanin by the action of tyrosinase. The distribution of pigment was shown to be due to the localisation of the precursor, tyrosine, not of the enzyme.

A third example of this kind of work was the study begun by Onslow of the inheritance of a metabolic peculiarity of the Dalmatian hound, and the correlation of this with the inheritance of coat-colour, etc.

For a man of only thirty-one years this would have been a remarkable enough record of achievement even had he been in normal health and circumstances. Yet, at the age of twenty, he received an injury to the spine, while diving, which rendered him completely paralysed below the waist, and only left him partial use of his hands and arms. For the remaining eleven years of his life he never left his couch and was often in pain and sometimes in danger. As an undergraduate he had been interested widely rather than deeply in many activities, in science, literature and art, in mountaineering, hunting, and other sport, and the accident seemed not to check but rather to concentrate his energies. Resolutely and courageously he took up the serious studies which led to the work outlined above. He conquered untold difficulties by his immense determination, learning to perform many details of chemical manipulation himself, and becoming a master of microscopic technique and an expert draughtsman. He kept very wide interests outside his scientific work, and was the centre of a large circle of friends. In 1919 he married the fellow-worker in biochemistry and genetics to whom we owe the present volume. It will be valued by many who were his friends, and it may confidently be hoped that others also will be led by it to draw inspiration from a life at once tragic and triumphant.

Our Bookshelf.

Die Biogenen Amine und ihre Bedeutung für die Physiologie und Pathologie des pflanzlichen und tierischen Stoffwechsels. Von M. Guggenheim. (*Monographien aus dem Gesamtgebiet der Physiologie der Pflanzen und der Tiere*, Band 3.) Zweite umgearbeitete und vermehrte Auflage. Pp. viii+474. (Berlin: Julius Springer, 1924.) 4·80 dollars.

THE term "Biogene Amine" is employed by the author to denote a somewhat heterogeneous group of organic compounds occurring in the plant and animal world, the only common property of which is the possession of one or more amino, or substituted amino-groups. In the author's opinion, all the amines in question may be produced in one of two ways; either by synthesis from simple substances or by the break-down of more complex compounds; as an example of the former mode of origin he quotes the production of primary amines from ammonia and alcohols or aldehydes with subsequent conversion into secondary and tertiary bases, etc., while the production of amines by decomposition is exemplified by the hydrolysis of phosphatides, proteins, or the de-carboxylation of amino-acids such as is commonly brought about by micro-organisms. The first chapter contains a description of the general methods employed for the isolation of such amines, together with an account of their general properties. The rest of the work is divided up into ten sections, nine of which are devoted to compounds of known composition, while the tenth deals with substances of unknown constitution such as the active principles of the pituitary and thyroid glands. In the section dealing with phenylalkylamines, attention is directed by means of structural formulæ to the comparatively close relationship subsisting between phenylethylamine and a number of complex alkaloids indicating a possible mutual inter-relationship between these substances.

The volume contains a quantity of information concerning the sources, mode of preparation, physical and chemical properties, and, where possible, the biochemical and pharmacological significance of the substances discussed. Not the least valuable feature is the very complete list of references at the end of the book, which covers the literature of the subject up to the beginning of 1923. For the verification of these references and much other valuable assistance the author gratefully acknowledges his indebtedness to Prof. Barger, of the University of Edinburgh.

The Specific Heats of Gases. By Prof. J. R. Partington and W. G. Shilling. Pp. 252. (London: Ernest Benn, Ltd., 1924.) 30*s.* net.

PROF. PARTINGTON'S book is remarkable in that, instead of dealing generally with the properties of gases, it selects for fuller treatment the single property of specific heat. In the case of steam, tables of fundamental data are available, in which the numerical results have been subjected to a critical sifting during a period of many years and are at least approximately accurate. No similar trustworthy data for gases have been available hitherto, and the object of the present volume is to supply this gap. This has been done in part by means of new determinations by the authors, but also by a critical survey of existing data, many of which have been recalculated from the experimental figures in order to bring them all to a common basis. As a result of this survey the eleven pages of original data of Table A are reduced to a single Table B of molecular heats at atmospheric pressure, whilst the data of Table C, giving values for every 100° from 0° to 2000° and 2300°, occupy six pages.

Theoretical views are touched on only lightly, as they have been of no real service in predicting data, and can only with difficulty be reconciled with the figures already available. The book is not intended for beginners, and "the peculiar difficulties of the undeveloped mind" have not been considered in writing it; it is, in fact, intended as a reference book for specialists, and its construction is such that it will obviously be indispensable to all serious workers in this field for many years to come. The book is printed with unusually narrow margins, especially at the top of the page; this gives to the pages the novel appearance of a "high waist-line," and is not unattractive, whilst it obviously permits of a better utilisation of a given area of high quality paper.

Electricity and Magnetism for Advanced Students. By S. G. Starling. Fourth edition. Pp. vii+612. (London: Longmans, Green and Co., 1924.) 12*s.* 6*d.* net.

THE rapidity with which physical knowledge is extending at the present time must be a source of no small embarrassment to writers of the more advanced type of text-book. The progress in the subject of electricity during the twelve years which have elapsed since the publication of this book has been of such a fundamental character that it could not be relegated to additional chapters or appendices. A considerable amount of revision was thus necessary if the new matter was not to be too obviously grafted on the original. It is good to find that Mr. Starling has recognised this necessity, and congratulations are due to him on the result, for the book is now up-to-date, yet still homogeneous. He could not, of course, attempt to deal exhaustively with the electron theory and other modern developments, but he has given a very useful survey of them which will serve as an excellent introduction to more detailed study, the more so as it covers the widest possible field. For example, considerable space is devoted to the question of atomic structure, and an account of Bohr's theory of the hydrogen spectrum is given. In connexion with the latter it may be pointed out that the generalised quantum specification was given by Sommerfeld in 1916 (not 1911 as implied), but had been previously proposed by W. Wilson (1915).

Altogether about one-fifth of the book is concerned with the newer developments of the subject. There is no doubt that the time was ripe for this revision, and the present edition is sure of an appreciative reception from a wide circle of students.

The Continent of Europe. By Prof. Lionel W. Lyde. Second edition. Pp. xv+456. (London: Macmillan and Co., Ltd., 1924.) 10*s.* net.

THE revised edition of Prof. Lyde's well-known volume is in large part a reprint, with slight verbal changes, of the original work, but the chapters dealing with eastern Europe have been recast and rearranged. Here

and there statements have been left that now require emendation, *e.g.* the sovereignty of Bosnia (p. 146), and there are a few surprising omissions, *e.g.* the Murman railway. The treatment of Europe by political unities has many advantages except where the principle of self-determination has been allowed to run riot in the creation of small States. In such cases Prof. Lyde has not literally adhered to the system.

The book retains its merits and some of its defects. It is not a text-book to which the student can turn for full treatment of any part of Europe, and it contains many statements that need to be tested in the light of facts and close examination. In tracing causal relationships the author not infrequently jumps steps in his argument, and this does not make the book any too easy to read. On the other hand, he is never commonplace and never wearies his readers by telling him the obvious. Every page is stimulating, unexpected, and provocative. Prof. Lyde's picture of Europe is impressionist and extraordinarily vivid. To an uncritical mind the book might be misleading, but the intelligent reader with some knowledge at his command should find its ideas and suggestions invaluable in a study of the complex human problems of Europe.

The lack of coloured maps, which were in the original edition, is no loss. A folded black and white political map of central Europe has been added. The sketch maps and diagrams have been retained with little change. In a few cases revision would not be amiss.

Morphologie générale. Membres et ceintures des vertébrés tétrapodes : Critique morphologique du transformisme. Par Prof. L. Vialleton. Pp. viii + 710. (Paris : Gaston Doin, 1923.) 60 francs net.

PROF. VIALLETON is the leader in France of the school of modern transformists who believe in the Darwinian explanation of the evolution of genera and species by the process of the natural selection of small variations, but consider that the larger groups have arisen by a more rapid process of profound mutation. To illustrate this doctrine he presents us with a handsome and very useful monograph on the limbs and girdles of the cheiropterygial Vertebrata. The descriptions given of the various bones and articulations are clearly written, and the numerous illustrations throughout the text are excellent. As a work of reference for students of osteology this monograph is invaluable.

Students of morphology will naturally turn with special interest to the chapters dealing with the theoretical conceptions of the origin of the girdles and of the pentadactyle appendages, but they will be disappointed to find that there is no reference to Graham Kerr's important external gill hypothesis or to Goodrich's brilliant researches on the nerve supply of the limbs and his support of the lateral fold theory. The author seems to favour a theory expounded by A. C. Geddes in 1912, which is based on the supposition that there is an anterior and central region of the body of Vertebrata which is not and never was metamerically segmented. Such a theory is, no doubt, acceptable to the modern transformist, but it will be difficult to persuade the morphologists of the older school that the structure of the Vertebrata as we know them is not founded on a completely metamerically segmented ancestral type.

The New Theories of Matter and the Atom. By Prof. Alfred Berthoud. Translated from the French by Eden and Cedar Paul. Pp. 259. (London : George Allen and Unwin, Ltd. ; New York : The Macmillan Co., 1924.) 10*s.* 6*d.* net.

PROF. BERTHOUD'S book is very attractive both in its literary style and in the form in which it has been issued by the publishers. The scope of the book, dealing as it does with electrons, X-rays, radioactivity, isotopism, quanta and atomic structure, is familiar, so that the way in which the matter is presented is of more importance than the table of contents. Whilst it does not shirk the mathematical method of exposition, the book is eminently suitable for the reader whose knowledge of mathematics is too small to enable him to follow the more technical treatises of some of the physical writers.

As a professor of physical chemistry, the author is well acquainted with the limitations of the typical chemist in this direction, and the style and value of his book can therefore be expressed clearly by saying that it describes the physical developments of the present day in a form in which they can be understood and appreciated by chemists. This statement implies that the book is also suitable for the general scientific reader. The fact that most of the pages contain only a single fount of type, broken here and there by a series of cross-headings and varied only by a sparing use of italics, has the happy effect of creating the impression that the volume is not a mere text-book, to be used when "cramming" for an examination, but a book to be read and enjoyed in an arm-chair. It can therefore be heartily commended to those who read for pleasure, as well as to those whose reading is dictated by more urgent necessities.

Les Protéines. Par Jacques Lœb. Traduit de l'Anglais par H. Mouton. (Nouvelle Collection scientifique.) Pp. viii + 243. (Paris : Félix Alcan, 1924.) 10 francs.

THE original volume of which this is a translation is already familiar to English readers, and there is therefore no need to recapitulate the author's views with regard to the significance of the Donnan theory of membrane equilibria in explaining the colloidal behaviour of protein solutions. In his preface to the French edition, dated October 1922, the author stated that the work was to appear in two parts, the first part being devoted to the stoichiometric and colloidal properties of proteins and the second to the theory of colloidal properties.

The present volume, published in 1924, after the author's demise, represents the first half only of the complete work, the translation of the second half not yet being completed. It contains two new chapters dealing respectively with the electric charge and stability of suspensions and emulsions, and the crystalloidal character of the solutions of certain natural proteins in water. In the latter chapter the author discusses the question whether proteins are kept in solution by the same forces which determine the solubility of crystalloids in water or by the electric double layers which keep particles of oil in suspension in water, and arrives at the conclusion that the conditions

vary with different colloids. The translation is on the whole good, but, owing to an extraordinary oversight, the title of the second chapter is translated as being a quantitative proof, whereas in fact it appears in the original English edition as a qualitative proof.

Siam. By W. A. Graham. Third edition. (In 2 vols.) Vol. 1. Pp. xii + 396 + 45 plates. Vol. 2. Pp. viii + 320 + 69 plates. (London: Alexander Moring, Ltd., 1924.) 42*s.* net.

IT is surprising that Siam should be comparatively little known in Great Britain, notwithstanding the part played by Englishmen in its recent development under two monarchs of marked European sympathies, one of whom indeed had been educated in England. Mr. Graham's "Siam" should do much to dispel this ignorance, as well as to arouse interest in a country which should repay investigation. Written originally as a short handbook, it has now expanded into two volumes to cover the developments of the last twelve years. From the scientific point of view, Siam is almost virgin ground. For example, except for a few partial investigations, the botany has scarcely been studied, and apart from Skeat and Blagden's investigations of the wild tribes in the south, ethnological data are practically not available. Such conclusions as Mr. Graham has to offer are really based upon material drawn from the adjacent areas of Further India. Setting aside the drawbacks inevitable in view of the fragmentary state of our knowledge in certain departments, Mr. Graham's book is an informative account of the country and its resources, and of the manners, customs, beliefs, and social organisation of its people. In the chapter on music and the drama, the reference to the interesting and characteristic dances is disappointingly brief.

The Home of an Eastern Clan: a Study of the Palaungs of the Shan States. By Mrs. Leslie Milne. Pp. viii + 428 + 20 plates. (Oxford: At the Clarendon Press; London: Oxford University Press, 1924.) 16*s.* net.

MRS. MILNE'S account of the social life and customs of the Palaungs, a people living in a northern Shan State, but quite distinct from the Shans and belonging to the Mon Kmer group, is the outcome of her linguistic researches. When she first came into contact with them in 1906, their language had been little studied. In the course of several visits to their country, she compiled a dictionary, and in acquiring a vocabulary took her informants through every stage of the ceremony or custom for which she wished to ascertain the associated groups of words. By pursuing this method, she not unnaturally acquired a good deal of information bearing on the psychology, the social life and religion of the people. This information is the subject matter of the present book. The reading public, whether it apprehends the immense labour which has gone to the making of it or not, will at any rate appreciate the result. Mrs. Milne has produced a most readable and entertaining book which at the same time is of considerable scientific value. A welcome feature is that, as an outcome of her method, she deals very fully with the early stages of the life of the individual—a subject which frequently is very inadequately treated in the description of a primitive tribe.

Laboratory Experiments in Practical Physics: to Accompany the revised edition of Black and Davis' "Practical Physics." By N. Henry Black. Pp. ix + 245. (London: Macmillan and Co., Ltd., 1924.) 4*s.* 6*d.* net.

THIS is a revised and enlarged version of the author's Laboratory Manual published in 1913. In addition to some fifteen new experiments, introductory paragraphs have been prefixed to each experiment in which principles and practical applications are discussed. While these often provide interesting information (*e.g.* that every Ford automobile has sixteen permanent magnets bolted to its fly-wheel), one could wish that some attempt had been made instead to give a logical and connected development of the subject. No doubt the academic method has its limitations, but it is possible to progress too far in the opposite direction, and the practical or utilitarian method, if carried far enough, may retain little of real educational value. However, the latter method seems to be enjoying a considerable vogue in the United States at the present time, and, judged by the appropriate standards, the book is probably an excellent one. It is certainly clearly written and carefully compiled, but it is too distinctively American in outlook to be likely to appeal generally to students in Great Britain.

Examples in Chemistry. By Dr. William W. Myddleton. Pp. viii + 134. (London: Methuen and Co., Ltd., 1924.) 3*s.*

DR. MYDDLETON has produced a very useful and attractive set of examples for calculation suitable for use in schools and, with a little supplementing, for Intermediate Science students. There are no sections explaining the methods of calculation, and the book consists entirely of examples for exercise. This is in some ways an advantage, since the book can be used by teachers who prefer different methods of dealing with the subject. The questions will bring to the notice of students who work through them a number of points not often found in such books, and it is clear that the questions will fit in well with modern methods of teaching the subject. The book can be recommended as likely to prove very useful both to teachers and students. Answers to all the questions are given.

Applied Chemistry. By Prof. Ira D. Garard. Pp. vii + 496. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1924.) 15*s.* net.

A STUDENT who has graduated with first-class honours in chemistry from one of the universities may be expected to know very little about the chemistry of the common things of life. The composition of cheese, bread, leather, paints and varnishes, inks and boot polish will generally be unknown to him. The chemical changes taking place during the cooking and digestion of food will probably be less well known than those involved in "organic preparations." Prof. Garard's book, which does not treat of "Applied Chemistry" in the sense understood in Great Britain, will assist many chemical students to a better understanding of things which are mysteries to them, and is an interesting though rather superficial supplement to the standard treatises.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Gravity Observations on the Indian Ocean and the Results of their Isostatic Reduction.

FOR years geodesists have anxiously awaited the securing of accurate gravity observations at sea for use in the determination of the shape of the earth and in testing the theory of isostasy. The gravity observations made at sea by Hecker, Briggs, and Duffield were a good step forward in this important work, but their results were not of the required degree of accuracy. They did, however, encourage us to believe that the problem would be solved in the not distant future.

Geodesists felt that the longed-for event had materialised when they read the communications from Dr. J. J. A. Muller, published in recent volumes of NATURE (September 15 and December 1, 1923; March 1 and May 3, 1924).

Dr. Muller reported on the determination of gravity at sea by Dr. F. A. Vening Meinesz, of the Geodetic Commission of Holland. Dr. Meinesz's work was done on a submarine, and the observations were made with the pendulum apparatus employed in the determination of gravity on land. I communicated with Dr. Muller, and also with Dr. Meinesz, and asked for further details in regard to the gravity work than had appeared in the letters in NATURE. I was given interesting and valuable information by them, but Dr. Meinesz will no doubt soon publish full accounts of his work, and it would be inappropriate to place in this note all the information that was furnished to me. I shall, however, discuss the isostatic reduction of five stations in the Indian Ocean for which Dr. Meinesz furnished the observed values.

Dr. Meinesz informed me that four pendulums were swung simultaneously in the same case or container in order to eliminate the effects of the motion of the submarine in which the pendulum apparatus was mounted. While observations were made, the vessel was submerged from 10 to 25 metres below the surface, in order to avoid the motion that would be imparted by waves if it were at the surface.

So far as I am aware, Dr. Meinesz is the first observer to use the pendulum apparatus on a boat, but it may be interesting to note that in a paper by me, entitled "The Bearing of Geodetic Investigations on the Geological Structure of the Pacific," presented at the first Pan-Pacific Scientific Congress conference held under the auspices of the Pan-Pacific Union at Honolulu, Hawaii, in August 1920, the following statement was made:

"It is hoped that a satisfactory apparatus may be devised for determining the intensity of gravity at sea, using special vessels or commercial vessels. There are several types of apparatus in existence, but no one of them gives results of sufficient accuracy for the study of isostasy. The writer suggests that it may be possible to obtain a fair value of the intensity of gravity at sea by the use of the land apparatus properly mounted on a vessel. The apparatus would have to be swung in double gimbals and should be placed near the point of minimum translation resulting from the pitching and rolling of the vessel."[1]

[1] Proc. First Pan-Pacific Scien. Conf., Honolulu, Hawaii, 1921, Spec. Pub. No. 7, Bishop Museum, p. 885.

It was with great satisfaction that I read that Dr. Meinesz had accomplished the accurate determination of gravity at sea with the use of pendulums. No doubt he arrived at the conclusion that the pendulum could be used independently of my suggestion in 1920.

Dr. Meinesz informed me that, so far as observations aboard the ship were concerned, the mean error from the observations alone were only one or two parts in 5 million in calm weather and rarely more than ten parts in rough weather. He feels that there should be better control of the temperature of the pendulum during the observations and of the rates of the chronometers.

The submarine was submerged at each station for 15 or 20 minutes, and the rates of the chronometers were dependent upon radio-signals received each day. It seems to me that in the work on a ship the principal difficulty arises from the fact that it is difficult to get a sufficiently accurate time interval from a chronometer which is only compared once a day with radio-signals. It would be better to have arrangements made with a radio-station to have accurate time-signals sent out each hour during the time gravity is being observed at sea. In this way, somewhat greater accuracy would be obtained.

The thought has occurred to me that a tuning-fork may possibly be used as the time-piece in getting accurate gravity observations with the pendulum, both on land and at sea. The tuning-fork would, of course, have to be made of material that would be only slightly affected in its elastic properties by changes in temperature, or some method would have to be devised which would enable one to determine with extreme accuracy the temperature of the fork. The material of the fork would necessarily have to possess constant elastic properties or values for any given temperature. If such a fork could be devised, a few oscillations of the pendulums compared with vibrations of the tuning-fork would give a value for the period of the pendulum. The tuning-fork, of course, would have to be standardised and rated at the base station.

With a letter dated August 2, 1924, Dr. Meinesz furnished the data given below for 13 stations in the Indian Ocean or in its ports:

OBSERVATIONS IN THE INDIAN OCEAN.

	Latitude North.	Longitude East of Greenwich.	g (unreduced).	$g_o'' - \gamma_o$.
1	11° 54′·5	53° 03′·5	978·286	+0·032
2	10 02	55 25	978·184	−0·006
3	7 57	61 53	978·136	+0·002
4	7 53	65 58	978·111	−0·021
5	7 56·5	68 46	978·102	−0·032
6	8 06	72 48	978·113	−0·024
7	7 20	77 28	978·099	−0·020
8	6 56·5 (Harbour of	79 51 Colombo)	978·118	+0·012
9	5 50·5	80 12	978·168	+0·080
10	5 32	80 12·5	978·014	−0·069
11	5 44	87 07	978·065	−0·020
12	6 02·5	92 50	978·024	−0·068
13	5 53·5 (Harbour of	95 19 Sabang)	978·181	+0·097

The values for g in the table above were reduced for the effect of the speed of the vessel during the observations, which lessened or increased the centrifugal force due to the earth's rotation. In computing the Bouguer anomalies shown in the last column, Dr. Meinesz applied a correction to take account of the depth of the submarine below the surface of the water.

It would have been interesting if isostatic reductions could have been made for all of these stations, but this was impossible in the short time that was available. However, reductions were made at the office of the U.S. Coast and Geodetic Survey by Mr.

C. H. Swick, Chief of the Section of Geodesy and Astronomy of the Division of Geodesy of the Survey, for stations 2, 3, 4, 5 and 11 of the above list. The results of Mr. Swick's work are shown in the following table:

PRINCIPAL FACTS FOR GRAVITY STATIONS IN THE INDIAN OCEAN ESTABLISHED BY DR. MEINESZ, OF HOLLAND.

No. of Station.	Latitude ϕ.	Longitude λ.	Depth, fath.[1]	γ_0.	Correction for Submergence.	Correction for Topog. and Comp.	Computed Gravity at Station (g_c).	Observed Gravity at Station (g).	Isostatic Anomaly.	
									$(g-g_c)$.	$(g-g_c-0{\cdot}008)$.
2	10° 02′	55° 25′	2300	978·187	+0·005	−0·016	978·176	987·184	+0·008	0·000
3	7 57	61 53	2400	978·129	+ ·005	− ·013	978·121	978·136	+ ·015	+ ·007
4	7 53	65 58	2400	978·127	+ ·005	− ·010	978·122	978·111	− ·011	− ·019
5	7 56	68 46	2400	978·128	+ ·005	− ·017	978·116	978·102	− ·014	− ·022
11	5 44	87 07	2200	978·081	+ ·005	− ·008	978·078	978·065	− ·013	− ·021
							Mean with regard to sign . . .		−0·003	−0·011
							Mean without regard to sign . .		·012	·014

[1] Depths were estimated from soundings shown on charts Nos. 854*a* and 854*b* of the Hydrographic Office of the United States Navy.

These five stations were selected because they were in the open ocean where the depths of the water vary from 2200 to 2400 fathoms, or from 13,200 to 14,400 feet. In metres, the depths are from 4025 to 4390.

The computed value at the station is based on the well-known Helmert formula of 1901, in which the first term is 978·030.

The values for g_c were corrected for the effect of the topography of the whole world and its compensation. The combined effect of these two are given in column No. 7.

In the column headed "$g-g_c$" are the isostatic anomalies based on the Helmert formula. It will be noticed that the largest anomaly is 0·015 dyne. The mean of the five anomalies with regard to sign is only −0·003, while the mean without regard to sign is only 0·012.

My formula, which is given in Special Publication No. 40 of the Coast and Geodetic Survey, is the same as the Helmert formula except that the first term is 978·038. The isostatic anomalies based on this formula are shown in the last column of the above table. With this formula the mean anomaly with regard to sign is −0·011, and the mean without regard to sign is 0·014.

It is possible that the uncertainty of the observed values at Dr. Meinesz's stations is of the order of magnitude of the difference in the two formulas used.

These small anomalies, with and without regard to sign, for the five stations over deep water in the Indian Ocean, seem to indicate very clearly that the crust of the earth below the area covered by the stations is in a state of isostatic equilibrium that is very nearly perfect. They also indicate that there is no large longitude term as advocated by Helmert and shown in his 1915 formula. That formula was discussed by me in Special Publication No. 99 of the Coast and Geodetic Survey.

It would appear from the results given above that Dr. Meinesz has made a valuable contribution to geodetic science, and that he has added another piece of evidence in favour of the theory of isostasy. Let us hope that he will be able to make isostatic adjustments for all of his stations in the Indian Ocean, the Mediterranean Sea, and in the Atlantic, and let us hope also that Dr. Meinesz will be able to continue his valuable work, and that geodetic organisations in other countries may embark on this new line of geodetic observations.

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Polarisation of Resonance Radiation in Magnetic Fields.

WOOD and ELLETT have shown that weak magnetic fields may greatly affect the polarisation of resonance radiation, the nature of the effect depending upon the relative orientation of the magnetic field and the electric vector of the exciting light. In the absence of a magnetic field, the resonance radiation emitted in the direction of the axis of Z by an atom excited by a beam of light parallel to the X axis and polarised with its electric intensity parallel to the Y axis is found to be more or less completely polarised, the per cent. polarisation, defined as $\frac{E_y - E_x}{E_y + E_x}$, varying from 90 in the case of mercury to 16·3 for sodium excited by both D_1 and D_2. The effect of a magnetic field parallel to the Z axis is to reduce this polarisation—the law of decay being quite accurately represented by an equation of the form

$$\frac{E_y - E_x}{E_y + E_x} = P_0 e^{-KH}.$$

The writer has recently observed that in D line resonance radiation with the magnetic field, the azimuth of the maximum polarisation is no longer parallel to OY, but is rotated in the direction of the Larmor precession. The angle of rotation is not directly proportional to the intensity of the field, probably because the interval between absorption and emission is not the same for all atoms. With D_2 resonance radiation of sodium, a field of 3·6 gauss rotates the azimuth of maximum polarisation 16·5°, and a field of 13·5 gauss rotates it 21°. Beyond this point, the azimuth of maximum polarisation cannot be determined with accuracy because of the decrease in polarisation due to the field. This rotation of the azimuth of maximum polarisation appears to be due to an actual rotation of the resonating atom. At first, it appeared that it might be due to rotation of the plane of polarisation by the layer of sodium vapour between the resonating atom and the observer, but such is not the case, for the magnitude of the rotation is independent of the thickness and density of this layer.

These observations were made in sodium freed from hydrogen as completely as possible and at temperatures of 85° to 95° C., where the vapour pressure of the sodium is so low that the time of a free path is large compared to τ, the average interval between absorption and re-emission.

It may be pointed out that by making suitable assumptions as to the manner of distribution of the time intervals between absorption and emission, we may calculate τ from the magnitude of this rotation.

E. Gaviola and P. Pringsheim have recently shown (*Zeit. f. Physik*, 25, 367, 1924) that the polarisation of sodium resonance radiation is due entirely to D_2, as one would expect from the character of the Zeeman levels involved. Using a different method, I made similar observations independently at about the same time (April and May of this year). The D lines were separated in the light from the exciting source by means of Prof. Wood's rotary dispersion scheme, and resonance radiation excited by either D_1 or D_2 alone.

D_2 alone shows polarisation. In addition, it may be pointed out that the $2p_1 - 2s$ and $2p_2 - 2s$ thallium lines show no polarisation in resonance radiation, as would be expected, since the *s* levels are above, while $2p_2 - 2d_2$ shows strong polarisation. The first and second doublets of the principal series of cæsium and potassium show polarisation in resonance radiation, due presumably to the more refrangible member of the doublet in each case.

For certain types of spectral lines, the theory of the anomalous Zeeman effect shows that resonance radiation excited in a magnetic field by plane polarised light must itself be partially polarised, because of the absence of certain components of the Zeeman pattern (Foote, Ruark and Mohler, J.O.S.A. and R.S.I., 7, p. 415, 1923.) I have found that in the *absence* of a magnetic field, lines of this type, *e.g.* $1s - 2p_1$ of sodium, $1s - 2p_2$ of mercury, $2p_2 - 3d_2$ of thallium, show polarisation; while those in which all components of the Zeeman pattern are to be expected, as $1s - 2p_2$ of sodium, $2p_1 - 2s$ and $2p_2 - 2s$ of thallium show no polarisation either with or without the field.

This work was done at the Johns Hopkins University, and is being continued at the Bureau of Standards.

A. ELLETT
(National Research Fellow).

Bureau of Standards,
Washington, D.C.,
November 15.

Heterogeneous Catalysis.

PROF. H. S. TAYLOR has pointed out to us that it is not clear from our paper on the heats of adsorption of oxygen on charcoal (Blench and Garner, J.C.S., 1924, 125, 1288) that the values were expressed in kgm.-cal. and also that we had not discussed the bearing of these results on the mechanism of heterogeneous catalysis. The latter point had, however, been reserved until further and more accurate data had been obtained, but, as it appears to be a matter of general interest, I propose to discuss it briefly in this letter.

The position, mode of orientation, and energy content of the atoms forming the surface of a homogeneous catalyst will very largely determine the part they play as individuals in the catalytic process, and it is not unlikely that a comparatively small number of the total atoms on the surface are the active agents in promoting the chemical change. This view is supported by the very large differences in energy content which have been shown to exist among the atoms on a carbon surface.

On admitting oxygen to an active carbon surface, heat is liberated which is due partly to the formation of carbon monoxide and dioxide and partly to the formation of an adsorption complex, C_xO_y. By allowing for the heats of formation of the two gases formed, it is possible to obtain a value for the "heat of formation" of the complex C_xO_y, which does not necessarily represent solely the heat liberated in its formation, but also includes any decrease in energy of the surface due to the liberation of the two gases. This heat of reaction, expressed in kgm.-cal./gm.mol.O_2 adsorbed, was often greater than the heat of formation of carbon dioxide. It decreased as the amount of gas admitted increased, and increased with the temperature of adsorption. The heat liberated ranged from 52 kgm.-cal. at 18° to 224 kgm.-cal. at 450° C. for the first small quantities of oxygen admitted. On subsequent admission of oxygen lower values than these were always obtained. These heats of reaction are of the same order as the energy liberated in the formation of the C-C linking as deduced from the heat of sublimation of carbon. Thus the valency of the surface carbon atoms is very far from being saturated by neighbouring carbon atoms.

The ratio of the oxygen atoms adsorbed to those giving rise to carbon monoxide and dioxide decreases with increase in temperature; in other words, a proportion of the atoms adsorbed at the low temperatures is liberated as gases at the high temperatures. Thus the differences between the heats of adsorption at two temperatures must be due to different selections made from the carbon atoms on the surface, and hence are an indication of the very widely differing energy contents of these atoms. The oxygen atoms which remain on the surface at any one temperature will be to a large extent those held by a number of carbon atoms, while those adsorbed on exposed carbon atoms, which are less tightly bound to the surface, will give rise to the oxides of carbon. Thus the high heats of adsorption are not due solely to the energy liberated on combination of the oxygen atoms with the surface, but also to that liberated on the removal of the exposed carbon atoms, *i.e.* carbon atoms with a high energy content, from the surface. Both energies are undoubtedly very high compared with the heat of formation of carbon monoxide, but without further work it is difficult to decide between their relative importance. The most active atoms are, however, removed on the first admission of oxygen.

A point of difference between the reactions of carbon and oxygen and a catalytic reaction lies in the fact that the atoms of the catalyst do not leave the surface although their relative positions with respect to one another may change during the reaction. It is, however, clear that those atoms lying in an exposed position on the surface, by virtue of their high energy content, will play a large part in the chemical process. They will be the most likely to possess the energy necessary for promoting the trigger action of catalysis. Also it can be seen why the surface becomes increasingly effective with use. If part of the heat liberated during the heterogeneous reaction is absorbed by the surface, this may result not only in an increase in the total surface but also in an increase in the proportion of exposed atoms on the surface, *i.e.* an increased free energy of surface per sq. cm.

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Seed Inoculation of Lucerne (*Medicago sativa*) and its Relation to the Motility of the Nodule Organism in Soil.

THE successful results that are being obtained in other countries from the inoculation of lucerne seed with the nodule organism (*Bacillus radicicola*, Beyerinck) have stimulated investigation of this subject in England. In this practice the details of the method used in the inoculation are of great importance. The method consists essentially in making a suspension of the bacterial culture in some liquid, and in using this suspension to wet the seed. In this way each seed is coated with a film of liquid in which the bacteria lie. There is evidence that after penetrating the tissues of the root the bacteria are unable to pass for any significant distance along it. Consequently, when the seed has germinated, the bacteria must progress or be carried through the soil in order to reach from the seed-coat to the various parts of the root system, where nodules are to be formed. A study of the factors affecting the motility

of the organism and its passage through soil has, therefore, an important bearing on the technique of seed inoculation.

A modification of Winogradsky's technique for staining bacteria in soil (1924, *Comptes rend. Acad. Sci.*, vol. clxxix. p. 367) has enabled the present authors to follow the passage of the nodule organism through sterile soil. It has been found that they will progress through light soil at an approximate rate of one inch in 24 hours, though the rate is affected by the soil texture. When a drop of water containing the bacteria in the rod stage is added to sterile soil, the spread of the organisms from the point of inoculation does not begin until after a considerable interval, and its commencement is accompanied by the conversion of a large percentage of the bacteria into cocci. If the inoculum consists of a suspension in milk, the bacteria begin to spread through the soil after a shorter interval. This is perhaps an explanation of the successful results obtained by using a suspension of the bacteria in skim milk for wetting the seed, a technique now practised in Scandinavia for inoculating lucerne. The effect of milk also emphasises how important is the nature of the liquid used in making the bacterial suspension for seed inoculation.

Bewley and Hutchinson (*Journ. Agric. Sci.*, 1921, vol. x. p. 144) found that the production of the motile coccoid stage of *Bacillus radicicola* was greatly stimulated by the presence of phosphates. The effect of inoculating sterile soil with a suspension of the bacteria in skim milk containing 0·1 per cent. soluble calcium phosphate, $CaH_4(PO_4)+2H_2O$, was therefore tested. It was then found that the spread of the organisms from the point of inoculation commenced almost immediately. It seemed probable that the use of a bacterial suspension in the above solution for wetting the seed would increase the chances of nodule formation by hastening the spread of organisms from the seed-coat, and thus increasing the volume of soil explored by them in a given time. Pot culture tests of seed inoculation were therefore made with lucerne, in which a bacterial suspension in a 0·1 per cent. solution of $CaH_4(PO_4)_2+2H_2O$ in skim milk was compared with a suspension in skim milk alone, such as is now in practical use. On averages of 10 parallel pots, increases in nodule numbers of 93 per cent. and 73 per cent. were obtained in two experiments by the addition of phosphate to the milk. There was also a favourable effect on the yield of the crop. The work is being continued and will be published in detail at a later date.

H. G. THORNTON.
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Capillary Action: Transpiration.

IF a capillary tube, A, Fig. 1, with a wedge-shaped cut in it at a distance of about 10 mm. from its upper end, at right angles to, and deep enough to make a breach in one side of its aperture, is lowered slowly into water the rising column of water pauses for an instant when it reaches the gap, which is necessarily higher than the surface of the water into which the tube is being dipped, and then leaps past it and rises to the top of the aperture.

When this tube is fixed in a cork as shown in Fig. 1; the cork inserted as a stopper into the mouth of a cylindrical vessel, B, containing water; the vessel, B, fixed in a circular piece of cork which acts as a stand for it; and a small sheet of thin blotting paper, *b*, drawn far enough into the cut to touch the thread of water in the aperture, the capillary tube acts the part of the stem of a plant, the blotting paper that of a leaf, and transpiration commences and continues uninterruptedly through the latter so long as the water lasts. A current of water flows up the aperture of the capillary tube and through the gap in it to the blotting paper from which it is evaporated continuously without creating any visible disturbance in the thread of water contained in that part of the aperture above the gap. As the surface of the water inside the vessel, B, is being lowered, air flows into the space above it through a fine capillary tube, *a*, which passes through the cork near the larger tube.

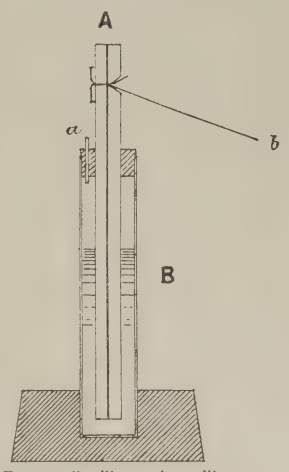

FIG. 1.—Capillary tube to illustrate transpiration. Half real size.

In an experiment with this apparatus carried out in May 1922, the dimensions of the sheet of blotting paper were 33 mm. by 43 mm. The edge of the sheet was drawn into the cut by means of a thread which passed round the back of the capillary tube and slightly compressed a small india-rubber tube which acted as a spring to keep it taut as shown. On placing the apparatus on one scale of a chemical balance in a glass case, in which there was also a basin containing chloride of calcium, and balancing it with weights in the other scale, it was found that when both scales were left free to move, one rose and the other fell so rapidly and continuously that their movement was clearly visible to the unaided eye.

Observed during a period of 491 minutes, it was found that the total weight of water evaporated in that time amounted to 1·1958 gm., or at the rate of 2·43 mgm. per minute. The aperture of the capillary tube was elliptical. Its area in cross-section, ascertained by calibration with a thread of mercury 93·2 mm. in length at 20° C. and weighing 3·21 mgm., was 0·02542 mm². It was thus equal to that of a circle 0·18 mm. in diameter, and the velocity of flow of water in the aperture was at the rate of 95·5 mm. per minute.

W. GALLOWAY.
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The Ballistic Theory of Light and the Michelson-Morley Experiment.

IN a note regarding my theory of variable stars, published in NATURE of October 11, p. 550, it is suggested that some difficulties would probably arise on the ground of the Michelson-Morley experiment. As the point is a very important one, I should be glad if space can be given me to make it clear.

The ballistic principle, on which my theory is entirely based, requires that light emitted from a source movable relatively to the observer shall exhibit a velocity compounded of the common velocity *c* and of that of the source. As in the Michelson-Morley experiment the source is at rest in respect to the observer, the ballistic principle requires that light travels with the same velocity *c* in all directions. Hence no displacement of the interference fringes may appear in revolving the whole apparatus. The negative result of Michelson-Morley experiment evidently agrees with the ballistic theory. The same

agreement must hold, in all the experiments directed to detect the total motion, for the ballistic principle has been just introduced from Ritz for the purpose of extending the mechanical principle of relativity to all physical phenomena. This means that the ballistic theory is a *relativistic* one, like that of Einstein, with the two advantages of preserving classical mechanics and of explaining variable stars.

For the sake of completeness, it must be remembered that only in one event would the Michelson-Morley experiment trouble the ballistic theory, that is, only if in repeating the experiment with extra-terrestrial light the result were also negative. Of course, an astronomical light source is not dragged by the earth; light speed, therefore, on the ballistic theory should appear to a terrestrial observer different towards and normal to the motion. Thus, an effect should be expected. As a matter of fact, this experiment proposed by myself in 1912 (*Nuovo Cim.* vol. 3, p. 345, 1912; *Phys. Zeit.* vol. 13, p. 1129, 1912), and recently attempted (R. Tomaschek, *Ann. d. Phys.* 73, p. 105, 1924), cannot give a decisive result, for many difficulties increase when the light falls on a movable mirror, as I have already pointed out (*Ann. d. Phys.*, 75, p. 195, 1924).

In conclusion, ballistic theories are very promising, because they enable us to explain all the phenomena of classical optics and electromagnetism, including the deflexion of light rays near the sun, and they are also fruitful in explaining variable stars, while they finally reconcile both the undulatory and the quantum theories required by recent discoveries.

M. La Rosa.

R. Università-Istituto Fisico, Palermo,
November 18.

The Rare Gases of the Atmosphere.

One of the unsolved questions of geophysics is whether the earth's atmosphere is mainly primitive, or whether its constituents have for the most part been evolved from the interior of the earth since solidification. Dr. Aston's letter (Nature, Nov. 29, p. 786) may help to answer this question. The tendency of a gravitating planet to collect heavier molecules to itself, and in certain circumstances to lose the lighter ones, would not by itself account for the rarity of the inert gases. Xenon and krypton have the highest molecular weights of all the atmospheric gases, and would therefore be the most abundant if this were the sole explanation. Possibly the ability of other elements to form stable solid and liquid compounds has co-operated. If so, we may contemplate a heated primitive earth surrounded by a tenuous atmosphere consisting largely of the rare gases as at present represented, with the possible exception of helium. The greater part of the atmosphere, the water, and perhaps the helium, would have been emitted from the interior in the course of the earth's development.

I am much indebted to the reviewer for his careful and kind notice, in Nature of November 22, of my book "The Earth." He has, however, misunderstood me in regarding as a lower limit my estimate of 0·14 astronomical unit as the radius of the primitive sun, at the time of the tidal encounter. It is an upper limit, based on the fact that the sun would have been too cold to be gaseous if its size were any greater. I doubt whether any serious change will be necessitated by the sudden death of the giant and dwarf theory while my book was in the press, but cannot as yet be sure.

Harold Jeffreys.

The Temperature of Mars.

In a recent paper (Pub. Ast. Soc. of the Pacific), Nicholson and Pettit calculate the temperature of the planet Mars, based on their radiation measures made at Mount Wilson. Most confidence is placed on measures made in the region 8 to 14μ, by the use of filter screens, and an emissivity of unity is assumed for all wave-lengths. However, Mars, being probably composed of material not unlike the earth, would radiate more like sand or quartz than like a black body, and it can be calculated from curves given by Wood ("Physical Optics") and data given by Rosenthal (*Wied. Ann.* 68, p. 783), that the average ratio of the emissivity of quartz to that of a black body in the region 8 to 14μ, is 0·819. The values of the emissivity of quartz given are far below that of a black body between 8 and 10μ; they are nearly the same from 10 to 14μ; the average ratio is taken.

It is believed that temperature calculations using this value for the emissivity, and the fourth power radiation law, will be more correct than when an emissivity of unity is assumed. For a given amount of received radiation, the temperature of the radiating body will be higher for a lower emissivity. Accordingly, the temperatures T given by Nicholson and Pettit have been recalculated by applying the method separately to each value of T.

$$\frac{T^4}{T_e^4} = 0{\cdot}819.$$

	T.	T_e.
Centre, full phase . .	280° absolute	294°
Limb	260°	273°
Pole cap	205°	216°
Integrated disc . .	250°	263°

Carl T. Chase.

Norman Bridge Laboratory of Physics,
Pasadena, Cal., November 15.

Low-Voltage Arc Spectra of Copper.

In my letter which appeared in Nature of October 4, p. 501, I reported work I had carried out on the low-voltage arc in copper vapour. I have since then succeeded in obtaining the line absorption of normal copper vapour. The lines which are certainly absorbed, and which, therefore, should be 1*s* combinations, are:

3247·55	2244·24
3273·97	2225·67
2492·14	2165·06
2441·63	

With slight uncertainty there are also the lines:

2181·68
2024·33

In addition, I find from combinations that 2178·91 should also be absorbed, but this is not sufficiently resolved from 2179·39 by the small spectrograph used.

By subtraction from the term 1*s*, the above lines give energy-levels which are all confirmed by combinations with other known terms of the copper arc spectrum. From the arc lines previously reported I have also calculated a number of other terms.

A paper is being written incorporating all these results.

A. G. Shenstone.

University of Toronto,
Toronto, Canada, November 26.

The Origin of Land Vertebrates.[1]

By Prof. E. S. GOODRICH, F.R.S.

WE are all agreed that the four-footed terrestrial vertebrates or Tetrapoda have arisen from some fish-like aquatic ancestor. Two chief changes must have occurred in the passage from water to land—one connected with respiration, the other with locomotion. Moreover, the land animal must have acquired a resistent skin. The fish breathes oxygen dissolved in water, which it takes in by its mouth and expels through its gill-slits, the gills on its gill-arches being organs of respiration.

In the tetrapod, the respiratory organ is a ventral bilobed diverticulum of the pharynx; air is taken in at the external nostrils, passes by the internal nostrils into the buccal cavity, and is thence forced or sucked through the median ventral glottis into the trachea and so to the distensible lungs.

The fish, also, swims by undulations of its body and tail and with the help of paired fins, stiff outstanding folds of the body-wall, each with an internal skeleton movably articulated at its base to the supporting limb-girdle. The walking limbs of the tetrapod, on the other hand, consist of paired pectoral and pelvic projecting limbs built on essentially the same plan, and each subdivided by movable articulations into three regions, the outermost bearing typically five digits. Hence it is called the pentadactyle limb.

The problem before us is, then, to explain how the walking tetrapod evolved from the swimming fish without any sudden alteration of the structure and function of its parts, by a series of gradual steps each of advantage in the struggle for existence.

Before considering the possible claims of any known fish to be considered as ancestral to the land vertebrates, we must first attempt to determine, without going into detail, what must have been the fundamental structure of the common ancestor of all the Tetrapoda. Since the Amphibia still lay their eggs in water and pass through a larval stage provided with gills, it is agreed that they represent the most primitive group of tetrapods living at the present day. The problem is thus narrowed to that of the origin of the class Amphibia. But all the modern forms of the class are highly specialised remnants of a much more ancient and primitive group known as the Stegocephalia (or Labyrinthodontia), which flourished in Carboniferous and Permian times—many of them far larger and more formidable animals than their degenerate modern descendants.

Briefly, we may conclude from a study of extinct and living Amphibia that the primitive ancestral tetrapod had the following chief characters in addition to the lungs and pentadactyle limb already mentioned. It was a heavily built animal, shaped somewhat like a salamander or newt, with a large head, a complete covering of bony plates and scales underlying a soft skin protected by a renewable outer cornified layer and provided with abundant glands to keep it moist when out of the water. The roofing of the skull was pierced by two orbits, two external nostrils, and a median pineal foramen. Internal nostrils opened on the palate. The Eustachian tubes led to a tympanic cavity closed by a tympanic membrane behind the quadrate. A columella auris extended between this membrane and the auditory capsule. Probably the lateral line system of sense organs, present in all fish and in the aquatic larvæ of Amphibia, persisted even in the adult. The brain had well-defined paired cerebral hemispheres. The heart was asymmetrically twisted and the atrium subdivided into left arterial and right venous auricles. The lung received venous blood from the sixth aortic arch and returned it aerated to the heart by pulmonary veins. A vena cava inferior made a short cut from the kidneys to the sinus venosus. The rectum and urino-genital ducts opened into a common cloaca.

Now we may ask from what known kind of fish could such a primitive tetrapod have evolved? What group of the Pisces is sufficiently advanced and at the same time sufficiently primitive to give rise to such a form?

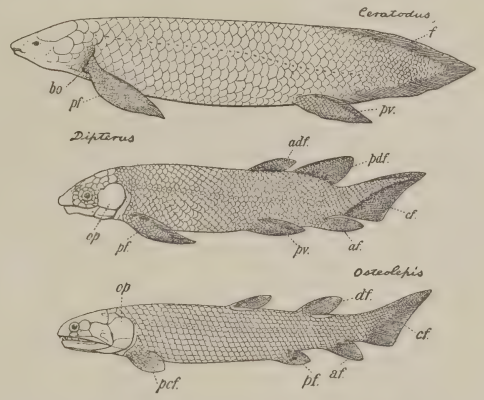

FIG. 1.—*Ceratodus forsteri*, the lung-fish of Australia; *Dipterus valenciennesii*, a Devonian dipnoan (after Traquair); *Osteolepis macrolepidotus*, a Devonian teleostome (after Traquair). From "A Treatise on Zoology," Part IX., by kind permission of Messrs. A. and C. Black.

We divide the Pisces into Chondrichthyes (sharks and rays), with a purely cartilaginous skeleton, and Osteichthyes, in which bone is present. Clearly the Chondrichthyes, with neither true bone nor true scales and with no form of air-bladder or lung, are not eligible. The second group, the Osteichthyes, contains the Dipnoi and the Teleostomi. We shall see that of these the Dipnoi alone display a considerable assemblage of characters which the ancestor of the Tetrapoda must have possessed.

The teleostomes include Polypterus and the Actinopterygii (Acipenser, Amia, Lepidosteus, and the Teleostei and many fossil forms). Of these the Teleostei, which appear only in the Jurassic strata, may be dismissed at once as far too specialised and modern—for it is obvious that the common ancestor of the tetrapods must have diverged from the piscine stem in Carboniferous if not in Devonian times. But even the lower living Actinopterygii show specialisations in the skeleton, brain, and viscera which prove that they all belong to side branches not in the direct line of ancestry.

In the Devonian strata, however, are found certain very primitive teleostomes, such as Osteolepis, which much more closely resemble what we believe to have been the ancestral form.

[1] Substance of a paper opening a discussion in Section D (Zoology) of the British Association at Toronto on August 13.

Indeed, as we pass downwards, we find a gradual convergence in structure between Teleostomi and Dipnoi, and between these and the Stegocephalia, which seems unmistakably to point to a common undifferentiated form from which all three could have evolved. It is just this sort of convergence as we pass to earlier and earlier fossils which makes the study of palæontology so fascinating—affording evidence not only that evolution has taken place, but also enabling us to trace out the course it has actually followed.

Following, then, the teleostomes down into the Devonian, we find that the osteolepids acquire a complete covering of thick scales of the peculiar structure I have named cosmoid, a complete set of roofing bones to the skull which may be compared almost bone for bone with those of the Stegocephalia (a comparison further borne out by the very similar disposition of the lateral line canals and the pineal foramen). Not only were there ventral external nostrils but also internal nostrils on the palate, as Prof. Watson has shown. Both the pectoral and the pelvic fins had outstanding scale-covered lobes.

Allied to Osteolepis, but, it would seem, somewhat off the main line of descent, are the Rhizodontidæ, represented, for example, by Eusthenopteron from the Upper Devonian of Canada and so well described by Whiteaves and Bryant. Primitive as they are, even these Devonian teleostomes are probably already too specialised in their jaw apparatus, large opercular bones, and fin skeleton to be the actual ancestors of the Tetrapoda.

There remains to be considered the very isolated fish Polypterus, surviving at the present day, with a closely allied genus, only in the rivers of tropical Africa. It has a strong superficial resemblance to the osteolepids and was long ago placed with them by Huxley in the group Crossopterygii.

Pollard and others since, relying chiefly on similarities in the roofing bones of the skull, have claimed that Polypterus is, of all living fish, that most closely allied to the tetrapods. The resemblance is, I think, to a great extent deceptive, and only such as might be expected in any fairly primitive fish. It is true that it has a ventral lung-like air bladder supplied from the sixth aortic arch. Nevertheless the structure of its scales, the jaw apparatus, the position of its double nostrils on the outer surface of the snout, the absence of a cloaca, the skeleton of the pelvic fin and girdle, and its specialised brain show that Polypterus is well on the actinopterygian line of specialisation, as I endeavoured to show in a paper on the subject before the British Association in 1907. Indeed there is some reason to believe that it may be the living representative of the ancient group of Palanoniscidæ.

Finally we come to the Dipnoi, that ancient branch of the Osteichthyes dating from Devonian times, but still surviving to-day in isolated remnants, of which the Australian lung-fish Ceratodus is the most primitive genus. Although the modern forms have a highly specialised dentition and have lost many of the dermal roofing-bones of the skull and marginal bones of the jaws, yet they retain several important characters indicating affinity with the Tetrapoda. They have internal as well as external nostrils, and a lung sac opening ventrally, receiving venous blood from the sixth aortic arch and returning aerated blood directly to the heart. The heart itself is remarkably amphibian in the structure of the truncus arteriosus, in the tendency of the valves of the conus to fuse to a spiral longitudinal septum; and even the atrium is beginning to become subdivided, so that the venous and arterial blood-streams pass separately to the right and left sides of the ventricle. The vena cava inferior and the anterior abdominal vein are well established. A cloaca is present, and the urino-genital organs conform to the amphibian plan, as do also the eggs and the larval forms. But more important still is the structure of the brain, which possesses distinct paired cerebral hemispheres. Even the skin resembles that of the Amphibia, being provided with abundant multicellular glands. All these resemblances, both conservative and progressive, can scarcely be due to convergence.

Two important points remain to be mentioned. In all the primitive tetrapods, the hinder region of the palato-quadrate bar (the upper division of the mandibular arch) is not only firmly attached to the skull by basal and otic processes, but also bears an ascending process separating the profundus from the maxillary branch of the trigeminal nerve. Among all the fishes, the Dipnoi alone are known to show this typical disposition.

The second point is that they alone among known fishes, with the possible exception of the more primitive osteolepids, have pectoral and pelvic fins of the same structure—thus sufficiently alike to have given rise to paired walking limbs. In other fishes the pelvic fins are too much reduced or specialised, too unlike the pectorals, to have developed into the tetrapod hind limb. The early Devonian dipnoan Dipterus approaches so closely to the osteolepids (in the structure of the skull, scales, fins, etc.), that we may be sure these forms cannot have moved very far from the common starting-point.

We may conclude that the earliest Osteichthyes diverged into teleostome and dipnoan branches and that the tetrapods arose from the base of the latter branch before the Dipnoi had acquired their characteristic specialisation in palate and dentition. The Devonian Osteolepidæ and Dipnoi seem to have been fresh-water forms, and it is probable that the transition from aquatic to terrestrial life took place in streams and pools, whence access to land was easy.

What exactly were the transitional steps from fin to walking limb we do not yet know. The fin skeleton of the osteolepids is scarcely known, and that of the rhizodonts is probably already too specialised. The living Dipnoi, on the other hand, help us to understand how aerial was substituted for aquatic respiration. For, while retaining gills and open gill-slits, they have become adapted to survival in rivers liable to be dried up or become foul in dry weather by acquiring a nasal passage from external to internal nostril (by closure of the nasal groove) and a lung for breathing air taken in at the surface. The lung had no sudden origin; but, as suggested by A. Goette and Spengel, was probably derived from a posterior pair of gill pouches which failed to open to the exterior, retained an ample blood-supply, and joined together ventrally. To this day the lung first appears in tetrapods as a pair of diverticula of the pharynx.

Thus without break or sudden violent change of habit or structure could an aquatic ancestor have evolved into an animal living on dry land.

The Optical Planetarium at Munich.

MECHANICAL devices intended to represent the motions of the planets date back to a very remote period and are said to have been constructed by the Chinese some 2000 years before the Christian era. It is certain that Archimedes and Posidonius constructed some such apparatus. Machines representing the Ptolemaic system were designed at different epochs up to the time of Copernicus.

In the latter part of the seventeenth century, machines were made by Roemer and Huyghens in conformity with the Copernican plan of the solar system, and various instruments have been devised at intervals up to the present day. It is interesting to note that Roemer presented one of his construction to Flamsteed, the first Astronomer-Royal. These machines all represent the motions of the planets by purely mechanical means, the planets being represented by balls and made to move in their orbits by systems of gearing. As a rule, a system of vertical concentric tubes of different lengths is employed, the innermost being the longest. To the upper end of each tube a radius vector is attached which revolves once for each revolution of the tube, and the lower ends of the tubes form the arbors of toothed wheels which are geared up to a vertical axial. Through this, axial motion is imparted to the whole machine. The radius vector attached to the top of each tube connects the tube with the ball representing the planet, and consists of two parts of different length. The longer is made to revolve round the tube, as has just been described, and the shorter, which carries the planetary ball at its extremity, is made to revolve round the extremity of the longer arm with the same angular velocity as the latter, but in the opposite direction. In this way true elliptic motion is produced, the ratio of the lengths of the two arms determining the eccentricity. The motion of the short arm is often produced by means of a pulley fixed to the planetary tube and connected by an endless cord with another pulley which is situated at the extremity of the longer arm and to which the shorter arm is attached.

It will be noticed that a person following the motions of these mechanical devices is in the position of an observer outside the solar system. Recently a new type of planetarium has been erected at Munich, and it seems to possess some striking advantages over the older and more cumbersome models. In the first place, the mechanical apparatus is compact, and the *images* of the planets are projected *optically* on the surface of a large hemispherical dome at the centre of which is situated the projecting mechanism. Images of fixed stars are also projected on the dome, and an onlooker at the centre of the dome sees the motions represented on a short time-scale as they actually appear to a terrestrial observer. A general idea of the planetarium will be obtained from Fig. 1. The dome is 33 feet in diameter.

Images of the 4500 fixed stars of the first to the sixth magnitude are projected on the dome by a straightforward method. Thirty-one projection bodies are mounted upon a spherical shell of gun-metal with a lamp of 200 candle-power at its centre, and are so divided up that thirty-one lantern slides derived from star-maps form a continuous picture. This device will readily be comprehended by a glance at the top portion of Fig. 2, which is a photographic reproduction of the entire projection apparatus. The stars are represented by means of discs of varying diameters, and the Milky Way is projected by means of a number of small lantern attachments giving nebulous images. The whole of this part of the apparatus is mounted upon an axis corresponding to the earth's polar axis, so that the projected images may move in such a way as to imitate the diurnal motion.

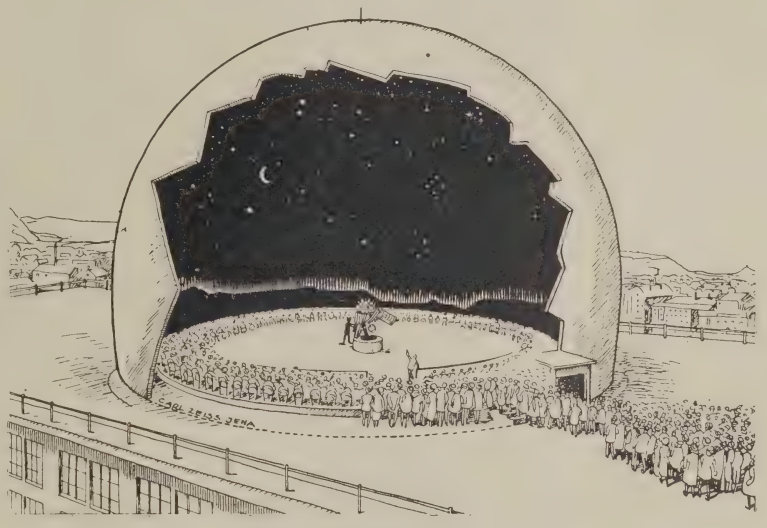

FIG. 1.—Sketch illustrating the planetarium in use.

The projection of planetary motions on the dome is necessarily a rather more complicated affair. The motions of five planets are represented, namely, Mercury, Venus, Mars, Jupiter, and Saturn. Uranus and Neptune are not represented, as they are purely telescopic objects. The motion of each planet is projected by a separate projector, and the principle of the projectors is briefly as follows. By means of a straightforward mechanical device two small steel balls representing the planet and earth are made to revolve round a central point representing the sun, and these balls are connected by a trellis linkage capable of adapting itself to changing distances. A small projection apparatus is attached to the end of this linkage, and consequently the motion of the projected planetary image on the dome represents the motion of the planet *as seen from the earth*. The planes of the paths of the planetary balls in these projectors are inclined at the correct angles to the planes in which the balls representing the earth move, these latter planes being all parallel to each other and inclined at the correct angle to the polar axis of the fixed star projector. The inclinations of the orbits of the planets and the obliquity of the ecliptic are thus taken into account. The orbits of the balls

representing the planets in the projectors are circular, but a crank mechanism takes into account the velocity changes associated with the eccentricity of the orbit. Briefly, the crank mechanism compels the planetary ball to describe a circular path about an eccentric point representing the sun. There is still a residual error left in the vectorial angle which in the most unfavourable case (Mercury when nearest to the earth) leads to an error of 6° in the position of the projected image. In the case of Mars, which comes next to Mercury in eccentricity, the residual errors amount to only $\frac{1}{5}$ those obtaining in the case of Mercury.

In the case of the sun projector, the trellis work to which the projection apparatus is attached simply joins the ball representing the earth to a fixed central pin representing the sun. The moon necessarily presents various complications arising from the comparatively rapid changes in the lunar orbit. The earth is represented by a fixed central pin, and the moon by a ball rotating about another central pin as in the case of the planets. This last central pin is set at an angle to the plane of the ecliptic, thus taking into account the inclination of the moon's orbit, and furthermore is made to rotate about a line perpendicular to the ecliptic, so as to represent the progression of the nodes. No attempt is made to represent the eccentricity of the lunar orbit, as it would have been of no avail unless some mechanism was introduced in order to represent the motion of the apses. This would have led to great difficulties in the gearing mechanism, and the lunar orbit is accordingly represented as circular. This leads to a maximum positional error of about 6°. The phases of the moon are imitated by mounting a small revolving stop behind the circular diaphragm which furnishes the projected image. Actually such a stop would represent the phases correctly through one complete lunation, but would furnish their mirror images during the next. Accordingly the phase projecting attachment has two alternately operating projection heads. The phases of the planets are not reproduced, since they are not naked-eye phenomena.

The projectors for the sun, moon, and planets will be seen on the left-hand side of Fig. 2. The precession of the equinoxes is also allowed for in the mechanism. The whole apparatus is driven by an electric motor, and by means of a change gear a sidereal day can be condensed into $4\frac{1}{2}$ minutes, 2 minutes, or 50 seconds. In order to exhibit the motions of the sun, moon, and planets more rapidly, a device is attached by means of which the polar axis can be disengaged and the motions of the solar system run at a rapid rate (exhibiting the annual changes in $4\frac{1}{2}$ minutes, 50 seconds, or 7 seconds) against the fixed star sky, the latter being unaffected by diurnal motion and showing only the slow precessional change.

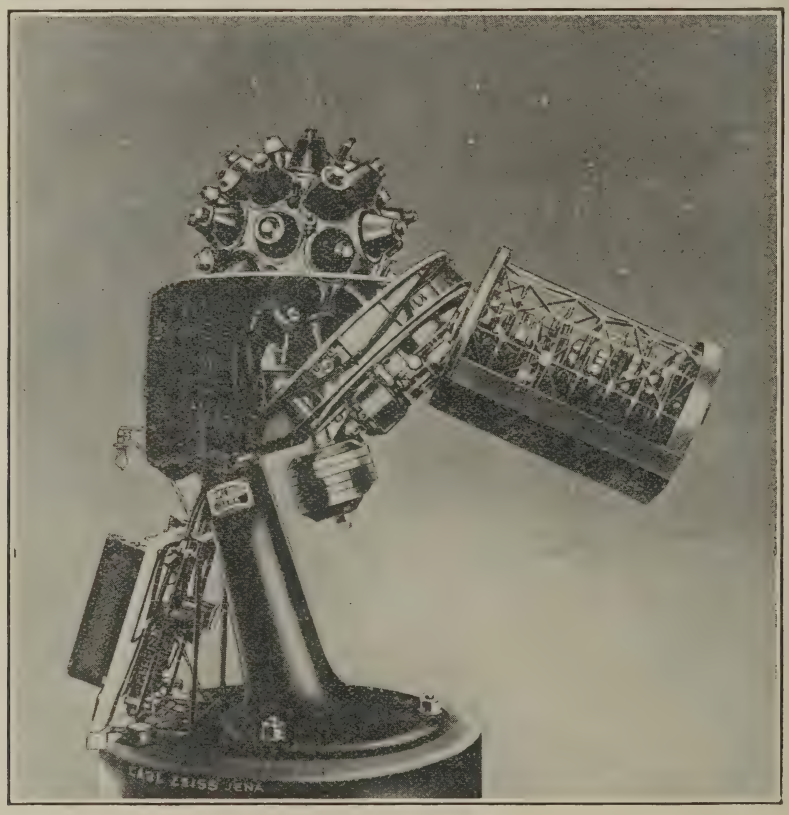

FIG. 2.—Projection apparatus.

The foregoing is a brief description of an instrument which probably represents the most successful attempt yet made to picture the heavenly motions. Its designer apparently claims that it is valuable as an astronomical work of precision. Some astronomers might possibly not feel inclined to lend unqualified assent to this claim, but few will deny the educational value of the apparatus, and there can scarcely be any doubt that the public at Munich and elsewhere will show their appreciation of the brilliant and successful efforts of all who have been concerned in the design and erection of this beautiful device.

Radio Communications.[1]

By Senatore G. MARCONI.

I HAVE always attached considerable importance to the problem of a practical directive system of radio communication. During my earliest experiments carried out in England more than twenty-eight years ago, I was able to show the transmission and reception of intelligible signals over a distance of 1¾ miles by means of an elementary beam system employing very short waves and reflectors, whilst, curiously enough, by means of the antenna or elevated wire system, utilising much longer waves, I could only at that time get results over a distance of half a mile.

The progress made with the non-directional long wave system was, however, so rapid and the results so immediately applicable to practical purposes, that it very soon became, and still remains, what might be called the standard system. It is regrettable that the study of short waves was neglected for a long period of years, for these waves, which, so far, are the only ones that can be confined to narrow beams, are also capable of being employed to give practical results unobtainable by the lower frequency system, which, up to now, has held the field for long-distance communication.

When during the War in 1916 I took up the systematic study of short waves, considerable doubt existed in my mind, and in that of other workers, as to whether the range of these waves might not prove to be too small for practical and useful purposes, particularly during daytime, if they might not be altogether too untrustworthy, and also as to whether large stretches of land, and particularly mountains, would not present absolute obstacles to their transmission over long distances.

In 1920 experiments were carried out by Capt. H. J. Round with duplex telephony on a 100-metre wave between Chelmsford and Southend, and the experiments were so successful that early in 1921 two stations which had been erected at Southwold and Zandvoord on the Dutch coast were put into commission experimentally, Southwold station utilising about 1 kilowatt to the aerial. Experiments were carried out, transmitting from these two stations to Norway in August 1921, and at Christiansund day and night telephony was easily received from both stations. At Christiania, about 700 English miles distant, very loud and constant signals were received during the hours of darkness and in the daytime on certain days, apparently when the barometer was low.

During these experiments the curious night distortion of telephone signals was discovered, particularly when transmission was overland, the major cause of which has more recently been discovered by Capt. Round in his work on broadcasting. Later, the results of these tests were merged into the general short-wave beam experiments.

During the tests carried out on the steam yacht *Elettra* in the spring and summer of 1923, I was able to discover that the short wave I was then using could not only cover great distances by day, and much greater distances by night, but that it was also quite trustworthy and that, moreover, large parts of continents and ranges of mountains did not materially reduce their working distance.

A series of tests was for the first time carried out with short waves over what might be termed world-wide distances during the winter, spring, and summer of this year, between Poldhu in Cornwall and receiving stations situated on ships at sea and also at such places as Montreal, New York, Rio de Janeiro, Buenos Ayres, and Sydney (New South Wales, Australia). All these tests proved to be successful, including the first telephonic communication with Australia ever realised, although the amount of power utilised at the sending station never exceeded 20 kilowatts. Very strong signals were obtained at all these places during the hours when darkness extended over the whole distance separating each of them from Poldhu, and weaker signals for a few hours when the sun was about the horizon at either end, the intensity of the signals varying inversely in proportion to the mean altitude of the sun when above the horizon. Although the signals were received with great strength at New York, Rio, and Buenos Ayres during the time when darkness spread over the whole or at least the major part of the great circle track separating these places from Poldhu, no signals at all were ever received, during these tests, when the same track or part of space was all, or substantially all, illuminated by the light of the sun.

While this limitation of the period of working to practically the hours of darkness constituted an undoubted disadvantage, still the economical advantages, together with the trustworthiness and possibility of working this system at far greater speeds than would have been feasible with the well-known high-powered long-wave installations, went far to convince me that the short-wave beam system would be capable of transmitting a far greater number of words per 24 hours between England and far-distant countries, such as Australia, than would be possible by the comparatively powerful, cumbersome, and expensive stations actually in use, or which were planned to be used, for Imperial commercial communications. It is a satisfaction to me to be able to state that the stations intended for this purpose in England and others to be installed in the principal Dominions and far-distant countries will all be on the beam system.

Commencing in August of this year, a further series of investigations was carried out between Poldhu and the yacht *Elettra*, the object being to endeavour, if possible, to find means of overcoming the limitation of working hours brought about by daylight, and also to test whether the effect of the reflectors would give the expected increase of signal strength over long distances. The yacht proceeded to Spain, then to Madeira, and afterwards to Italy. From Naples we sailed for Beyruth in Syria, touching at Messina and Crete, returning to Naples via Athens.

At Madeira it was ascertained that a reflector at the transmitting station increased the strength of the received signals in accordance with our calculations, but that, notwithstanding this increase of strength, when using a 92-metre wave, the daylight range was

[1] From the inaugural address to the Royal Society of Arts delivered on December 11.

only very slightly augmented. Comparative tests were carefully carried out with waves of 92, 60, 47, and 32 metres also at other places in the Atlantic and Mediterranean.

These tests enabled us to discover that the daylight range of practical communication over long distances increased very rapidly as the wave-length was reduced, the 32-metre wave being regularly received all day at Beyruth, whilst the 92-metre wave failed to reveal itself for many hours each day even at Madeira, notwithstanding the fact that the distance between Poldhu and Madeira is 1100 miles, entirely over sea, whilst that between Poldhu and Beyruth is 2100 miles, practically all over mountainous land. Our observations went to confirm the fact that for waves between 100 metres and 32 metres the daylight absorption decreased very rapidly with the shortening of wave-length.

These results were so interesting and satisfactory that I immediately decided to try further tests over much greater distances. In October of this year, transmission experiments were carried out on a 32-metre wave from Poldhu to specially installed receivers at Montreal, New York, Rio, Buenos Ayres, and Sydney (Australia). Although the available power utilised at Poldhu was only 12 kilowatts, it was at once found possible to transmit signals and messages to New York, Rio, and Buenos Ayres when the whole of the great circle track separating these places from Poldhu was exposed to daylight. During a complete day transmission at fixed intervals carried out last October with Sydney, New South Wales, that station received the Poldhu signals for 23½ hours out of the 24, and a 48-hour test which was only completed on December 10 fully confirmed the result.

The tests from England to places situated south of the equator, such as Sydney, Buenos Ayres, Rio de Janeiro, and Cape Town, are particularly interesting for the reason that the waves have always in these cases to traverse what may be called a summer zone. They are therefore subjected to an averaging effect of conditions, which can never possibly exist when the transmissions take place only between stations situated in the northern or southern hemispheres. During November some successful receiving tests were carried out in England, from a low power transmitting station in Australia utilising waves of 87 metres. During the present month of December, trials have been continued with Canada, the United States, Brazil, the Argentine, and Australia, and also, for the first time, with Bombay and Karachi in India and Cape Town in South Africa. The power utilised at the Poldhu station during all these tests was 15 kilowatts.

The results have fully confirmed my expectations in regard to the behaviour of the various wave-lengths over such great distances, and I have no doubt that the information gained will render possible the installation of comparatively low power stations capable of establishing and maintaining commercial services by day and by night between England and the most distant parts of the globe.

The low cost of this system both in capital and running expenses, compared with that of the existing type of stations, must prove to be very great, and should bring about the possibility of a reduction in telegraph rates for all long-distance communications, besides making direct communication with some of the smaller outposts of the Empire commercially remunerative. Already the size and power of some of the most modern long-wave stations was becoming a serious question from a financial point of view. The newly equipped station at Buenos Ayres, for example, which was designed primarily for communicating with Europe over a distance of about 6000 miles, employs 800 kilowatts and an aerial supported by ten towers, each 680 feet high. This station usually works on wave-lengths of about 12,000 and 16,000 metres. Another example is the British Post Office station which is being erected near Rugby, which, when completed, will employ 1000 kilowatts and an aerial supported by 16 towers, each 820 feet high, while the station being erected in the Union of South Africa was designed on a similar gigantic scale.

I am now firmly convinced that the beam stations employing only a small fraction of this power and much lower and fewer masts will be able to communicate at practically any time with any part of the Empire, and I cannot refrain from expressing my strong personal opinion that these powerful long-wave stations will soon be found to be uneconomical and comparatively inefficient in so far as long-distance commercial communications are concerned. Although we have, or believe we have, all the necessary data for the generation, radiation, and reception of electrical waves, as at present utilised for long-distance communications, we are still far from possessing anything approaching an exact knowledge of the conditions governing the propagation of these waves through space. These results indicate quite definitely that the well-known Austin formula is inapplicable to these waves. Another formula will have to be devised, based on the results of further investigations.

Reflectors of practical and economical dimensions are only efficiently applicable when short waves are used, and, although very long distances have been covered by these waves without the use of directional devices, I am convinced that these will be found to be essential for ensuring the carrying out of commercial high speed services. The disadvantageous effect called "fading" is sometimes a source of serious trouble when receiving signals transmitted by means of short waves, although much less serious than when waves of several hundred metres in length are employed. According to our experience, the use of reflectors diminishes fading, and also tends to overcome its effects by enormously increasing the strength and therefore the margin of readability of the received signals.

Increasingly large and expensive reflectors could, of course, be used with longer waves than 100 metres, but the results of all recent tests seem to indicate that the shorter waves present the greatest advantages, one of the most important being that their reception is very much less liable to interference by the effects of atmospheric electrical disturbances, or "X's."

If these waves are destined to carry a considerable part of the most important long-distance telegraphic traffic of the world, it may well be necessary in the near future, by international legislation, to regulate their use and safeguard them from preventable interference.

The Leeds University Celebrations.

DISTINGUISHED representatives of universities throughout the British Empire and of learned societies and professional bodies gathered together at Leeds during last week to join with local bodies in congratulating the University of Leeds on the attainment of its majority—an event which coincides with the jubilee of the parent institution, the Yorkshire College of Science. In the course of a series of important ceremonies spread over the whole week, the outstanding events were the sermon preached by the Archbishop of York in the Parish Church, Lord Balfour's great speech at the University dinner, the eloquent words with which Sir Michael Sadler reviewed the University's history, the addresses delivered by delegates at the official reception, and Sir Berkeley Moynihan's brilliant survey of the record of surgery in Leeds.

The wide and influential response to the invitation to participate in these celebrations is a tribute to the success which has attended the efforts of this young University. But it is not in this fact that the real significance of the gathering is to be found. Rather is it to be taken, first, as a demonstration of that fellowship within the world of learning which, important in its direct help to the advance of knowledge, may also exert a profound influence in producing a better understanding between the peoples of different countries; and, second, as evidence of the general recognition of the fact that of all the progress which has been made in education during the last fifty years, nothing has been so remarkable as the growth of the modern universities. Of this growth, the University of Leeds provides a good example, and it is perhaps to this more than anything that is due the representative character of last week's brilliant assembly.

The Yorkshire College of Science opened its doors on October 26, 1874, as the result of the efforts of a Yorkshire Board of Education the purpose of which was to bring about the development of scientific instruction in the county. The ground had been prepared for this new venture by the work of the Mechanics' Institutes, the formation of science classes, and the growing opinion in favour of scientific training as an aid to industry. Sir Michael Sadler puts forward the view that the aims of the promoters of the College were not so narrowly utilitarian as has generally been supposed, believing that they had in their minds a larger view of the purposes of the College than they thought it necessary to disclose. Their arguments were mainly based, however, on the industrial needs of the country, and they defined the objects of the College as being "to supply instruction in those sciences which are applicable to the Manufactures, Engineering, Mining, and Agriculture, of the County of York, also in such arts and languages as are cognate to the foregoing purpose." But, even if their aim was wholly utilitarian, it seems unnecessary to seek excuses for them. They were without question pioneers whose ideas were well in advance of general opinion, and their efforts achieved a notable development in higher education. Some there were who felt at the time of the establishment of the College that it was being confined within unduly narrow limits. Amongst these was Dr. Lyon Playfair, than whom the College could have had no more competent adviser. Lord Frederick Cavendish, the president of the College, was also emphatic in urging the avoidance of a one-sided concern. It is clear, therefore, that, whatever may have been the opinion of the general body of promoters, there was influential and expert support for the opinion expressed in the columns of NATURE on October 14, 1875: "If the County is as earnest in furthering its welfare as we believe it to be, the institution ought not to remain long on its present limited basis."

The widening of the curriculum of the College came about very quickly, and the cause of it was not primarily the pressure of outside opinion but the demand from within, coming both from the professors who were appointed to teach science and from the students who were in attendance for the purpose of studying science. Both staff and students found the need for literary studies if their work was to secure its best results. Some credit for the development must be given also to the external examinations of the University of London, which demanded a wider range of knowledge than could be gained within the early curriculum of the College. It was the work of the Cambridge University Extension Lectures scheme which made possible, only three years after the beginning of the College, the addition of literary and historical subjects to its courses of study. The College took over the work of the Extension Committee in 1877 and, in the following year, renamed itself "The Yorkshire College." In 1884 the Yorkshire College joined forces with the Leeds School of Medicine (which had been at work since 1831), and three years later attained university status by admission into the Victoria University. In 1904, having unsuccessfully opposed the dissolution of this Federal University, the Yorkshire College secured an independent Charter as "The University of Leeds."

Perhaps the most remarkable thing about the history of the Yorkshire College and the University of Leeds is the fact that from its very beginning until the present day its growth has continued without cessation. In this it has more than kept pace with the development of public opinion in favour of university education and with the realisation of the value of scientific research. Its governing body, constituted on a representative basis, has been able to retain its independence while accepting large sums of money from the State and the Local Authorities, and from other contributing bodies. This position (not maintained without certain struggles) has enabled the University to develop in a way which would scarcely have been possible under restrictions imposed by external authority. The University has attached more importance to staffing than to buildings, and, though it may have suffered in appearance, its policy has been more than justified by its results. Served by men and women of distinction, performing work of high value, and having the advantage and the dignity of self-government, the University has attracted to its governing body men of great business capacity, and its affairs have always been managed with efficiency.

The congratulations which have been showered upon the University of Leeds on the occasion of its jubilee indicate the general satisfaction of sister institutions and the public with the manner in which a College

founded on unambitious lines has grown in the space of fifty years into a University with nearly 2000 students and a staff of 268, constantly widening its range of studies, developing a strong Faculty of Arts while maintaining the distinction of its scientific work, retaining through all this expansion the atmosphere of friendliness in which it justifiably takes pride, and meeting its financial obligations in face of an annual expenditure increased in the space of six years from 70,000*l.* to 173,000*l.*

The University of Leeds is also entitled to congratulation for its present resolve to continue its progress in spite of the severe financial difficulties which stand in the way. It has set itself the great task of providing buildings worthy of its high purpose and of enlarging its endowment for scientific research. The purpose is one which deserves and will no doubt receive general commendation, and our best wish for the University is that its present enterprise will be crowned with a success equal to its past achievements.

Obituary.

Prof. Iaroslav Hlava.

WITHIN recent times the Czechoslovak nation has suffered several losses of eminent professors of its Charles' (Bohemian) University, which have been recorded in NATURE. Prof. Iaroslav Hlava died in Prague in his seventieth year on November 1. Prof. Hlava was the senior of the medical faculty and its eminent, most representative member. He was professor of pathological anatomy and of bacteriology, but he had to establish the chair of that science for our nation, for up to the year 1882 it was represented only by German professors. He began his career as a demonstrator of Prof. Klebs in Prague and then studied under Conheim, Weigert, Wirchow, Recklingshausen, Cornil, Vulpian, and Stricker.

Hlava became in 1884 associate professor, and in 1887 ordinary professor; later he was dean of the faculty, and in 1906 Rector Magnificus of our University. He was a great teacher of pathological anatomy. But he was also a well-known scientific investigator, and the number of his scientific discoveries and publications is too great to be mentioned here in detail. The principal object of his investigations were the infectious diseases, the modern teaching of which celebrated its triumphs at a time when Hlava was a young man. Bacteriology was in our country closely connected with his name. His special study was that of exanthemata, especially of scarlatina and of exanthemic typhoid fever, but this investigation proceeded very slowly, owing to the scarcity of this disease, and was brought to a close only during the War. His other investigations covered histology, epidemiology, and parasitology.

Hlava published most of his papers in the Bohemian language, and established for this purpose a special Collective Journal. To every paper a French résumé was added, and so Hlava's work became known in foreign countries. How it was appreciated there is evident from the great interest by which his numerous papers were received at different scientific congresses, especially French, Russian, Polish, and Jugoslav. A proof of it is given by the fact that he was not only a member of Bohemian learned societies like the Bohemian Academy of Sciences, and president of our Medical Society and of the High Sanitary Council, but also president of the Bohemian national committee at many scientific congresses, and foreign associate of the Academy of Medicine in Paris, member of the military Medical Academy of Petrograd, and a number of other medical societies in various countries. He received three high Serbian decorations. The imposing monument which exists in his wonderfully up-to-date Pathological Institute (called Hlava's Institute) will be a permanent symbol of his scientific significance.

BOHUSLAV BRAUNER.

CAMBRIDGE mourns the death, on December 7, of Richard Irwin Lynch, who for forty years was Curator of the University Botanic Garden. Mr. Lynch was born at St. Germans, Cornwall, in 1850, and went to Kew at the age of seventeen. He rose to the position of senior foreman, which he held until 1879, when he came to Cambridge. Of his many publications, all written in a fresh and charming style, perhaps the best known is his book on Iris. He is also well known by the Cineraria and Gerbera hybrids he raised. The University gave him an honorary degree of M.A. in 1906, and in the same year he received the Victorian Medal for Horticulture from the Royal Horticultural Society. In 1923 he received the Veitch medal inscribed "To R. Irwin Lynch for his work in Horticulture." He was an accurate botanist and an assiduous collector, and few of the present generation know how much Cambridge owes to him. On his retirement in 1919 he went to live at Torquay, a move deeply regretted by his numerous friends in Cambridge, who would have enjoyed his companionship, and been glad of his help and advice about everything to do with gardening.

H. G.-C.

WE regret to announce the following deaths:

Prof. Hugo von Seeliger, professor of astronomy and director of the observatory at Munich, and formerly president of the Bavarian Academy of Sciences, on December 2, aged seventy-five.

Dr. Otto Pufahl, professor of metallurgy in the mining department of the Berlin Technische Hochschule, on November 18, aged seventy.

Dr. Carlo De Stefani, professor of geology and physical geography in the Royal University of Florence, on December 12.

M. Eugène Simon, correspondant of the Paris Academy of Sciences in the section of anatomy and zoology, and author of the "Histoire naturelle des Araignées," on November 17, aged seventy-six.

Dr. Felix Tannhäuser, extra-ordinary professor of mineralogy and geology at the Technische Hochschule and the University of Berlin, on December 2.

Current Topics and Events

IN the Rationalist Press Association Annual for 1925 there is an interesting and suggestive article by Sir Arthur Keith on "Capital as a factor in Evolution." The gist of it is that we see in the biological order a closely similar use of saving for the purpose of higher development to that which we see in the sociological order in the use of capital. Sir Arthur develops the argument in considerable detail both in the case of the fowl, where the yolk-saving habit is carried to a very high point, and also in that group of fishes which lie near the ancestral line of the higher vertebrates, namely, the Selachians (sharks, rays and dog-fish). The argument is a continuation of Francis Balfour's discovery of forty years ago that the key to many of the obscure problems surrounding the development of the higher vertebrates may be found by studying the embryology of the Selachians. This is specially true of the structures which allow the young to draw their nourishment from the womb of the mother. The placenta is the most wonderful of these devices gradually developed. In the case of man it is just in the later intra-uterine period that the new and characteristic features of the brain and body are invented and worked out. We may then fairly continue the argument to the period of dependence prolonged after birth and after childhood. Only capital, that is saving, makes this possible. Knowledge is absorbed and increased owing to the shelter and the leisure provided by capital. This is, of course, only one aspect of the case for capitalism, but for those who care first for the intellectual stability and progress of mankind it is perhaps the most important: it is unfortunately the most easily overlooked by the Communists either of Russia or anywhere else.

AT a meeting of the Institution of Electrical Engineers on December 18, Mr. Donald Murray gave a very interesting forecast of the telegraphy of the future. It is common knowledge that the present system of telegraphy is far from satisfactory. Telegraph lines could be loaded to many times their present capacity without any change being necessary; the delays occur at the sending and receiving ends. Mr. Murray points out that if printing transmitters and receivers were installed in each user's office or home, it would be possible for him by means of automatic exchanges to receive or to send long printed messages over any distance in a few minutes. The method is past the experimental stage. The British Post Office has received and transmitted printed messages over considerable distances for several years. The introduction of automatic telegraph exchanges is merely a question of time. In the new telegraphy any ordinary typist working at from 40 to 80 words a minute could send the message which would be received in full printed form in a few minutes' time, no matter how great the distance between the sender and the receiver. The main obstacle in the path of progress is the price of the teletype machines, but once the demand increased to tens of thousands there is no reason to suppose that the price would be appreciably greater than that of a good typewriter. A probable development would be the broadcasting of printed news by a teletype receiver which could be actuated through the ordinary telephone wire. The use of the teletype printer will shortly take place in the United States, as both the Western Union and the Bell Telephone Co. are offering facilities to business men. The continually extending use of automatic telephones and telegraphs will gradually reduce the number of telephone girls and telegraph operators. Another effect will be to speed up to the utmost limit the rate at which business men work.

IN the account of the experiences of the Mount Everest expedition which appears in the December number of the *Geographical Journal*, Mr. N. E. Odell, who climbed to nearly 27,000 ft., makes some important observations with regard to the use of oxygen at high altitudes. He believes that if a man has been acclimatised at altitudes of say 22,000 or 23,000 ft., he can do without oxygen. Furthermore, he thinks that oxygen used liberally may be regarded as a source of danger by preventing the user from proper acclimatisation, and greatly increasing the chances of his collapse if the apparatus breaks down. The weight of the present apparatus, about 30 lb., combined with its bulk, obviates any advantage to be gained from it. Mr. Odell records the interesting physiological fact that all members of the recent expedition who had served in previous attempts acclimatised quicker than new-comers. He concludes by stating his belief that Mount Everest can be climbed without oxygen, and that if a high climbing party carries it in future, it should only be in small quantities, as an emergency measure, and must be contained in much lighter apparatus. Articles by other members of the expedition give a full account of the attempt on the summit, and are illustrated by a number of beautiful photographic plates.

THREE recent papers on the laws governing population growth were discussed by Dr. T. H. C. Stevenson, of the General Register Office, at a meeting of the Royal Statistical Society held on December 16. Dr. Stevenson stated that the birth-rate for Europe as a whole, which during the nineteenth century, so far as covered by the official records, had not varied very greatly, took a sudden downward plunge with the advent of the 20th, and continued to fall, at an accelerating pace, until the outbreak of war in 1914 spoilt the comparison. Germany was much more affected by this movement than England and Wales, where the birth-rate decline during the fourteen years before the war had been very similar to that of Europe generally. This fact might have contributed towards fixing the date for putting Germany's war machine in motion. If the death-rate had varied without reference to population conditions, and in the opening years of the present century, the birth-rate also, this would make the future course of population all the

more difficult to prognosticate. The very suddenness of the change suggests interference with the laws of Nature, as by increased practice of contraception, rather than a change in the laws of Nature themselves.

THE Natal Museum has issued two series of pictorial post-cards, ten in each series, illustrating the mammals of South Africa. They represent photographs of natural groups set up in the Museum and, as the groups have been mounted in natural attitudes and arranged amidst surroundings representing as closely as possible the special habitat of each species, the cards provide an excellent series of illustrations of the characteristic mammalian fauna of South Africa, mainly antelopes, but including elephant, rhinoceros, zebra, and lion. They are very pleasingly reproduced and of considerable artistic merit, and are, at the same time, an eloquent tribute to the fine work which is being done at the Natal Museum. With each series is issued a leaflet in which a reasoned plea is made for the international protection of the African fauna. The cards, by showing the reader of the pamphlet the beauty of what he is asked to protect, should be very helpful propaganda in enlisting practical support for the cause which Dr. Warren, as indeed all naturalists, has at heart. It is to be hoped that the series of cards will be extended to other groups of animals, for they must prove of great educational value as an aid to the teaching of natural history in the schools of South Africa.

DR. JOHANNES BÜTTIKOFER, director of the Zoological Garden at Rotterdam, has been elected a foreign member of the Zoological Society of London.

THE Foulerton Award of the Geologists' Association will be presented to Mr. A. L. Leach at the annual general meeting to be held next February. Mr. Leach was honorary secretary of the Association for the period 1913–1918.

THE Aerodynamics Experimental Department of the Royal Aircraft Establishments requires a number of test assistants. Applicants must have had technical training to the standard of a degree in natural science or engineering, and be willing and medically fit to fly as observers. Applications, marked A. 43, should be sent to the Superintendent, R.A.E., South Farnborough, Hants.

PROF. C. VERNON BOYS has been awarded the second Duddell Memorial Medal by the Council of the Physical Society of London. According to the terms of the Duddell Memorial Trust, the award is "for the advancement of knowledge by the invention or design of scientific instruments or by the discovery of materials used in their construction." The award to Prof. Boys was by a unanimous decision of the Council.

THE Safety in Mines Research Board requires the services for a year of an investigator to carry out work on the strengths of various structures for the support of underground workings in coal-mines. The possession of a university degree or its equivalent in engineering is a necessity. Forms of application, returnable not later than December 31, can be obtained from the Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1.

DR. F. P. STOWELL has been elected as the first Aquarium Research Fellow of the Zoological Society of London. Dr. Stowell is a graduate of the University of Liverpool, where he has been carrying out research in chemistry. The Fellowship, which is tenable for 3 years, is of the value of 350*l.* a year, and has been established for the investigation of the conditions affecting aquatic life in fresh and salt water aquaria. There were twenty candidates for the Fellowship.

APPLICATIONS are invited by the London School of Hygiene and Tropical Medicine (Division of Tropical Medicine and Hygiene) for the post of assistant in helminthology. Candidates must hold a science degree and be qualified in medicine or veterinary medicine. Applications, with particulars of candidates' experience and research, copies of their scientific contributions, and the names of not more than three referees, must be received by, at latest, January 1, by the Secretary of the School, Malet Street, W.C.1.

THE Harrison Memorial Prize selection committee announces that it is unable to make an award of the Harrison Memorial Prize for 1924. According to the terms of the trust deed, the award is in the hands of a committee consisting of the presidents of the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry, and the Pharmaceutical Society, and is given "for the most meritorious and promising original investigations in any branch of pure or applied chemistry" of the previous five years.

THOSE who have contributed to the proposed memorial to the late Dr. and Mrs. Augustus D. Waller will be glad to know that the sum of 2000*l.* has been subscribed towards the memorial at the London (Royal Free Hospital) School of Medicine for Women, and a trust deed has been drawn up embodying the resolutions of the final meeting of the Committee and subscribers held on July 17 last. The money has been handed over to the Council of the Medical School; it is being invested as a capital sum, and the interest will be applied for purposes of scientific research. The sum of about 105*l.* has so far been subscribed for the proposed memorial of a Waller Research Room at St. Mary's Hospital. If the scheme does not materialise in a year, the donors will be consulted as to the use of their money. A complete list of subscribers has now been prepared.

CATALOGUE E issued by Messrs. Flatters and Garnett, Ltd., 309 Oxford Road, Manchester, lists the lantern slides which that firm has available for purchase or hire. It consists of no less than 100 closely printed pages with a few representative

reproductions, and includes a wealth of subjects, mainly of a natural history type. The slides showing various plant associations should be particularly useful. There are numerous slides illustrating technical features of botanical, geological, zoological, and related specimens, while sections of the catalogue are also devoted to astronomy, textile fibres and machinery, and so on. A useful index to the subject matter concludes the pamphlet.

A BIBLIOGRAPHY of meteorological literature prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office, Air Ministry, No. 6, has recently been issued by the Royal Meteorological Society. The bibliography is now published in six-monthly parts; prior to 1921 it formed a part of the Society's Quarterly Journal. The publication is of great value to meteorologists in different parts of the globe, especially as the science of the weather is now making such rapid advances; it helps the inquirer to sort out literature on the branch of work with which he is interested. The divisions deal with the physics of the atmosphere, the upper air, and with more ordinary topics such as temperature, rain, wind, atmospheric electricity, and weather forecasting.

THE Institution of Heating and Ventilating Engineers is offering to assistants in the profession the following premiums: the Lumby, value 10*l.* 10*s.*, the Sirocco, value 10*l.* 10*s.*, and the Grenville, value 5*l.* 5*s.*, each carrying a medal of the institution. The Lumby premium will be for the best paper submitted dealing with, or any subject connected with, heating or hot-water supplies; the Sirocco premium for the best paper submitted dealing with ventilation and the general application of fans; air washing, air conditioning, dust and fume removal, mechanical draught, etc.; and the Grenville premium for the next best paper on any subject included in the above. Each competing essay must be written under a *nom de plume*, with the name and address of the sender in a separate sealed envelope, and be sent to reach the secretary of the Institution, 38 Victoria Street, S.W.1, not later than March 31 next. Further particulars are obtainable from the secretary.

Our Astronomical Column.

BRIGHTNESS OF PLANETS AND STARS. — The *Chaldaean* (vol. vi. No. 21) contains an interesting article by C. Schoch on the brightness of stars and planets at various distances. The most recent values of the planetary albedoes are employed. The earth seen from the moon is of mag. −16·6, but Mars seen from Phobos is −22·5, very little fainter than the sun seen from Jupiter, which is −23·2. The earth from Venus is −6·5, seven times as bright as Venus from the earth.

The brightest planet, seen from another planet, is Venus from Mercury, −7·7 mag., the earth from Venus coming next with −6·5. The moon from Venus is −2·4.

Of satellites seen from their primaries, our moon is very much the brightest, mag. −12·55; the two next brightest are Phobos from Mars −8·0, and Io from Jupiter −7·7. The table emphasises the fact of the great superiority of our moon as a light-giver, compared with the combined light of the satellites of the other planets, even if all could be full together.

The paper also gives the absolute magnitudes of several fixed stars. The three brightest are Deneb (α Cygni) −7·2, Rigel −5·8, Canopus −4·2, but as their parallaxes are very small, there is considerable uncertainty about these values.

THE DISTRIBUTION OF ENERGY IN STELLAR SPECTRA.—An interesting paper by Dr. C. G. Abbot on this subject appears in the *Astrophysical Journal*, vol. 60, p. 87. In place of the bolometer which he used in his earlier investigations of energy distribution, the author has employed a new type of radiometer, specially designed by Dr. E. F. Nichols for this type of work and used with the Mount Wilson 100-inch telescope arranged in the Coudé form. The deflexions were read visually on a phosphorescent scale placed 5 metres from the radiometer mirror. Observations were made in this way at fifteen different wave-lengths in the spectra of nine bright stars, and the results (reduced to normal conditions by comparison with solar observations) are given in diagrammatic form. It is interesting to note the very pronounced double maximum in the case of Rigel, and also the fact that Vega and Sirius (which are both of type Ao) show different energy distributions—the point of maximum, in particular, being very different in these two stars.

A tentative comparison is made of these curves with the theoretical "black-body" curves, and the diameters are computed of perfect radiators which would give emissions equal to those of the stars at the same temperatures. These diameters are found to compare favourably both with interferometer measures of stellar diameters and with Russell's theoretical values.

MECHANICAL ANALYSIS OF PERIODICITIES. — A problem of very frequent occurrence in astronomy is that of determining, from a set of observed values of a character (such as magnitude or radial velocity) which varies with time, the periodic time of variation. A mechanical method of solving the generalised problem has been applied by H. de Miffonis, and is described by him with detailed drawings in the *Astrophysical Journal*, vol. 60, p. 133. The principle underlying this instrument is to choose beforehand a definite length (*e.g.* 2 inches) to represent the required period, and then to alter the time scale of the observations by means of adjustable "time bars" until the period has the chosen length. The observations are represented by black dots on celluloid strips. Other dots are then arranged at intervals of two inches (in the time direction) on either side of the observation dots over the whole range of the instrument, and the time scale is adjusted by means of a hand wheel until these dots all lie as nearly as possible on a smooth curve.

The machine appears to be rather elaborate for its purpose unless a great amount of such work has to be done, but a useful description is added of a graphical method of solving such problems, involving the same principle, which can be used if the number of observations is insufficient to warrant the building of the machine as originally designed.

Research Items.

STONE IMPLEMENTS FROM TEXAS.—In the *Journal de la Société des Américanistes de Paris* (vol. xvi. N. Sér.), Dr. Chas. Peabody describes a number of implements of chipped flint from Kerrville, 120 kilometres north-west of San Antonio. There are in this area a large number of mounds of small dimensions varying from five to fifteen metres in diameter. So far as observed, these were not burial mounds and they usually occur along water-courses, particularly on a tongue of land between two streams. The specimens were obtained entirely from the surface. They include hammer stones; chipped axes with platforms usually covered with the original crust, varying from five to twenty centimetres in length, and very rough; arrow-heads with and without tangs; lance points, ceremonial and other, a few resembling Solutrean *feuilles de laurier*, with an occasional tendency to the sinuous edge and alternate retouching; knives, sometimes with flattened bases and stop-ridges for hafting, showing a striking similarity to Upper Palæolithic knives and scrapers. Among the scrapers, side scrapers are rare, but great ingenuity was shown in forming "snub-nosed" scrapers; while the long scrapers are identical with the *grattoirs carénés* of the Upper Palæolithic. Other forms were drills and spokeshaves. Flints are never found on the mounds, but lying near by. The patina is varied, generally blue or white. As Kerrville lies at the point of contact (at the beginning of historical times) of the Shoshoneans, Athapascans, and Coahuitlans, variety is to be expected, and it may be possible to establish the existence of trade and trade routes. To this the discovery of a piece of hæmatite, which is not known to occur in the neighbourhood, appears to point.

HUMAN MIGRATIONS.—An analysis of human migrations by Dr. Réné le Conte in the current issue of *Scientia* suggests a classification into those which are caused by violence and those which were carried out peaceably. Each class is capable of further subdivision. There are, for example, the armed movements of whole peoples in search of new land to cultivate or new lands for pasture, the latter to be distinguished from nomadism. Next military conquest, and, thirdly, military colonisation, to which the system of marches instituted by Charlemagne is closely related. A further class of migrations consists of the flight of families and individuals from a conqueror or invader. Peaceful migrations may consist of a peaceful penetration, usually mercantile, by land or sea, such as gave rise to Syracuse and Carthage. Permanent trans-oceanic migration is exclusively a feature of modern times. Temporary and seasonal migrations, though falling within the class of pacific migrations, have contributed nothing to the formation of peoples, as those who take part in them return to their own countries when once their object has been accomplished. Peaceful migrations are of more importance than the warlike, as is borne out by the fact that 250,000 Austrians landed in the United States in 1909–1910, as against 200,000 Wisigoths who crossed the Danube in A.D. 376.

ARABIC NUMERALS.—Dr. Karl Mischke, in an article in *Der Stein der Weisen*, Heft 14, in discussing the origin of the Arabic numerals, points out that the Roman numerals from 1 to 10 originated from the primitive custom of reckoning on the fingers of the two hands, and that it would be natural to assign the Arabic numerals to a similar origin. The Indian numerals do not at first sight appear to throw any light on the problem, but a comparison of archaic Indian forms found in early inscriptions with Chinese figures, which show less divergence from their original form, does suggest a derivation similar to that of the Roman numerals. Whereas, however, the Roman figures are based upon the fingers held in an upright position, in the archaic Indian and Chinese script they are regarded as held horizontally, one, two, and three being represented by a corresponding number of horizontal strokes, four by the clenched hand with the fingers held vertically, the back being towards the observer, and five by a side view of the clenched hand with the thumb uppermost. The remaining digits are formed on the analogy of the Roman numerals, $5+1$, $5+2$, and $5+5=10$, eight, however, being two fours, and nine, ten minus one. The rapidity in execution possible when a pen is substituted for the Chinese brush is responsible for the curved form of the 2, 3, 8, and 9 in the Indian script, while the Chinese retains an angular or only slightly curved form.

YELLOW FEVER IN NORTHERN BRAZIL.—While there was no reason to regard the yellow fever of Brazil as different from yellow fever occurring elsewhere, the micro-organism isolated from cases of the disease in Ecuador, Peru, and Mexico had not been experimentally demonstrated as the cause of Brazilian yellow fever. Indeed, two commissions, in 1919 and 1921, had failed to isolate the *Leptospira icteroides* from several cases studied in Bahia. A joint commission of American and Brazilian workers, therefore, proceeded to investigate the disease in Bahia in the latter part of 1923 and early part of 1924 (Hideyo Noguchi *et al.* in Monographs of the Rockefeller Institute for Medical Research, No. 20, August 1924). The commission succeeded in isolating two strains of Leptospira from two out of nine cases of yellow fever investigated, and these were proved by serological and other tests to be identical with the strains isolated elsewhere.

THE HAIR TRACTS OF MAMMALS.—Prof. F. Wood Jones (*Jour. Anat.*, vol. lix. pt. 1, pp. 72-82) puts forward some interesting views of the causation of hair tracts in mammals, including man. While not denying the efficacy of other theories on the question to account in part for the facts observed, he is of opinion that the most potent cause in the production of hair tracts is the animal's own peculiarities in the method of conducting the toilet of its coat. He bases his conclusions on the study of the habits of living marsupials and an examination of the tracts in embryos. He finds that the hair tracts, particularly the reversed or abnormal ones, coincide exactly with the direction in which the hair is combed during toilet operations, and he gives some very interesting observations on the way in which these operations are conducted and the specialisation of parts of the limbs for this purpose. He finds that the hair tracts of the adult, including the reversed tracts, are clearly shown in the embryo before it is able to influence the direction by scratching, and concludes that here there is a clear case of the inheritance of acquired characters, the whole complexity of reversals, whorls, and partings having been ingrained on the coat by the cumulative effects of the toilet methods of its ancestors. In this he supports and extends the views of Dr. Walter Kidd.

GEOLOGY OF SOUTH AUSTRALIA.—In the Trans. and Proc. of the Royal Society of South Australia, xlvii., 1923, Sir Douglas Mawson contributes two papers on the geology of the South Australian Highlands, including one on the igneous rocks of the northern

Flinders Range, in which he records a further occurrence of the primeval boulder clays belonging to the series now known as Adelaidean ; they have been often regarded as Lower Cambrian, but are now generally assigned to the Upper pre-Cambrian. In a paper on part of the South Australian Highlands north of Adelaide, he confirms the discovery by Dr. E. O. Teale of another locality of Permo-Carboniferous glacial deposits. Dr. Howchin describes the sections along the eastern side of the Gulf of St. Vincent and accepts the view that the chief fossiliferous beds are Miocene, and not Eocene as held by Tate ; he shows that the Miocene has been extensively faulted and is covered unconformably by the Pliocene.

STATISTICS OF OIL PRODUCTION.—Some interesting figures emerge from a perusal of a statistical report on petroleum production prepared by G. B. Richardson and others as a chapter of the Mineral Resources of the United States for 1922, issued last July. Up to the end of that year, the world's cumulative output of petroleum, reckoning from 1859 when Drake drilled his now classical oil-well in Pennsylvania, amounted to more than ten billion barrels. Of this colossal total, three countries together have contributed 90 per cent., namely, the United States (62·3), Russia (19·0), and Mexico (8·8). In the year under review the highest single year's output was obtained, 858,715,000 barrels constituting the world's production, this figure representing a 12 per cent. increase over the previous year (1921) and incidentally double the amount produced in 1914. During 1922 the United States produced nearly 560 million barrels of oil, due to the extraordinary flush output of the great fields of the Los Angeles Basin, California, those of the Mid-Continent and of the Gulf Coast regions ; an increase of 18 per cent. over that country's production in 1921, this figure represented 65 per cent. of the world's total production for the same year, and 8 per cent. of the world's cumulative output since 1859. These figures throw a flood of light on the economic position of the industry during the years 1922 and 1923, which together have proved a period of extravagant over-production of petroleum resulting in a widespread slump in commercial activity, a serious depression from which the industry is only just showing signs of recovery. There is reason to believe that the figures for 1923, now just becoming available from authoritative sources, will eclipse those of 1922 ; these two years may well represent the peak of the world's production of oil, so that there is some ground for anticipating a gradual decline ultimately traceable from the current year. The other feature of 1922 worthy of note to British oil interests is that this was the year when Persia, by an output of 22,247,000 barrels, rose to fourth place on the list of producing countries ; India came seventh with 8,529,000 barrels, Sarawak eleventh with 2,849,000 barrels, Trinidad next with 2,445,000 barrels, Canada nineteenth with 179,000 barrels, and England last with 1000 barrels. Finally, in this year the United States exported 136,000 barrels of domestic crude oil (not refined products) to England, and 361,000 barrels to Germany ; the major export of crude oil went to Canada, which received 8,194,000 barrels.

HUMIDITY IN THE NETHERLAND INDIES.—In Verh. No. 8, vol. i., part 6 of the Publications of the Royal Magnetic and Meteorological Observatory of Batavia are published valuable results on relative humidity, tension of vapour, evaporation, and fog, discussed under the direction of Dr. C. Braak. The Dutch text gives much valuable data in considerable detail, and there is a brief English summary. At stations having no well-developed dry season, the mean monthly values of humidity range generally between 85 and 90 per cent. Relatively low monthly values occur at stations which have a well-developed dry season ; the lowest monthly means occur mostly in September and range from 67 to 70 per cent. There is a great difference in the humidities at the high mountains of Java and those of Sumatra. The stations at the latter have a wet climate during the whole year, the lowest monthly average on Mt. Singgàlang, in May, being 87 per cent., a value 17 per cent. above that on Mt. Pangerango in July. Considerable value is attached to wet bulb temperatures, and in Batavia when the wet bulb reading exceeds 26° C. the heat becomes troublesome. Evaporation is naturally much higher in the day than in the night ; at many stations it is more than ten times as great, as a result of the relatively high wind velocity and the relatively low humidity. A chapter is given on dew and morning fog, and during prolonged drought dew is said to compensate partly for deficient rainfall. Dense haziness occurs in abnormally dry years, and in the eastern part of the Archipelago dense fog is sometimes experienced ; 1902 is especially mentioned for the worst fog for thirty years. The fog was dry and the nights were without dew ; on the east coast of Borneo high trees were not visible at a greater distance than 20 metres ; dust is supposed to have taken some part in the phenomenon.

WHY WIRELESS WAVES BEND ROUND THE EARTH.—In the December issue of the *Philosophical Magazine*, Sir Joseph Larmor explains the bending of wireless waves round the earth as due to the presence in the upper atmosphere of electrons or light ions produced by the intense ultra-violet solar radiation (see also NATURE, November 1, p. 650). Such ions would increase the speed of propagation of wireless waves by an amount proportional to their number per c.c. and to the square of the wave-length of the waves. To provide the necessary curvature of the path of the radiation round the earth, only about 500 ions per c.c. out of the 10^{15} molecules per c.c. still present at a height of 50 miles from the earth's surface are necessary. Absorption of the radiation would take place at low altitudes owing to the presence of gas molecules, and in the upper regions according to the number of ions per c.c. There would be a layer in the upper atmosphere through which radiation would be transmitted with little absorption, and the energy shed down to the earth from this layer would allow the signals to be received at the surface.

CONTACT ELECTRICITY.—Messrs. A. Coehn and A. Cuss, in the *Zeitschrift für Physik* of October 28, describe a series of experiments to determine the charges produced by contact between metals and dielectrics, in a high vacuum. They show that by heating the substances employed, so as to drive off all moisture and adsorbed gas, the results can be reproduced with certainty, and that the charge depends (*a*) on the nature of the metal, its position in the Volta series, that is to say, its tendency to give off electrons ; (*b*) on the power of the dielectric to take up positive metal ions. Mercury and the amalgams of the "noble" metals were charged positively in contact with all the dielectrics examined, which included diamond, quartz fused and crystalline, "felsenglas," sodium glass, ebonite, sealing-wax and amber. The amalgams of other metals were charged positively at low concentrations, the charge diminishing to zero as the amount of metal in the amalgam increased. For definite concentrations which differed for different dielectrics, the charges of the amalgams became negative, increasing as the amount of metal in the amalgam increased. With

diamond, even the amalgams of the alkali metals were positively charged for all concentrations. This implies that diamond in no circumstances takes up positive metallic ions.

DENDRITIC STRUCTURES IN CARBON STEELS.—In a cast steel, the elongation, reduction of area, and angle of bending are always smaller than in forged steel of the same composition. The material is rather brittle and will not resist an impulsive force. These defects are generally considered to be due mainly to the dendritic structure, which reveals itself by macro etching. The removal of this structure is an important process in the treatment of steel. It is usually done by forging and annealing, and therefore a considerably larger size of ingot is required than that actually used. If, however, the dendritic structure could be removed by a simple process of heat treatment, this would be a great benefit to the metallurgical world. The question has been investigated by Mr. Torajirô Ishiwara in a paper entitled "The Effect of Impurities on the Dendritic Structure in Carbon Steels and their Diffusion at High Temperatures" (Science Reports, Tohoku Imperial University, Series I. vol. xii. No. 4). He finds that the dendritic structure in ordinary carbon steel ingots is effaced at 100° or 200° below the liquidus line. This treatment, however, would spoil the material, since it would be badly overheated. It would appear, therefore, that mechanical work is really necessary. The author has found that quick cooling in the solidification interval favours the formation of dendrites in a steel ingot, and that carbon affects the crystallisation very little. Phosphorus has the most powerful effect of the other elements usually present, and, to a less extent, silicon and manganese. The minimum concentrations of these elements which make the ingots dendritic are nearly equal to the maximum amounts actually present in ordinary steels.

DIRECTION-FINDING BY RADIO. — The Radio Research Board is making an elaborate study of the variations of the apparent bearings of radio transmitting stations as determined by well-known radio methods of direction-finding. An account has recently been issued of the experiments which were carried out for the Board extending from February 1921 to March 1922. (Department of Scientific and Industrial Research: Radio Research Board. Special Report No. 2: Variations of apparent Bearings of Radio Transmitting Stations. Part 1: Observations on Fixed Stations, February 1921–March 1922. By Dr. R. L. Smith-Rose. Pp. x+96. (London: H.M. Stationery Office, 1924.) 3*s*. 6*d*. net.) A number of directional radio receiving sets were erected at universities or Government experimental stations in Britain. The sites chosen were on flat open ground, and so far as possible trees, metal work, and overhead wires were avoided. Regular observations were taken of the radio bearings of many transmitting stations, chiefly in Europe, the positions of which were accurately known. Many thousands of observations were taken, and Dr. R. L. Smith-Rose has summarised the results. Unfortunately, no very definite results beyond those which are already known can be deduced. While extreme variations exceeding 60° were observed when determining the direction of Moscow from Aberdeen, a distance of 1500 miles, almost equally large extreme variations were observed when determining from Bristol the direction of Poldhu. In all cases the variations were worst at night. The experiments were mostly confined to long waves having a range from 2000 to 9000 metres. In most cases also they passed over considerable tracts of land in some portion of their path. In an introduction, Mr. F. E. Smith points out that in the latter half of 1922 the investigation was extended to the comparatively short 450 metre wave which is used at present for commercial direction finding in Great Britain. It was possible with this wave-length to make experiments with waves that had passed entirely over sea. Under these conditions, comparatively satisfactory results were obtained at distances up to 100 miles, the maximum error being only a few degrees. We are looking forward with great interest to the further account of the experiments on short waves.

HYVAC OIL PUMP.—The Hyvac Two-stage Rotary Oil Pump (sold by W. Edwards and Co., 8a Allendale Road, Denmark Hill, S.E.5), in common with other rotary oil and "box" pumps, consists essentially of an eccentric steel cylinder rotating about a horizontal axis within a tank filled with oil of low vapour pressure. The inlet and outlet openings are close together, one on each side of a single sliding steel vane which moves in the cast-iron pump casing, and, by means of a spring, is caused to bear continuously against the outer surface of the inner cylinder. The latter in its eccentric motion serves to trap and expel a "parcel" of air in each revolution. The oil is sufficient to prevent leakage into the high vacuum. Two such units are mounted side by side on the same shaft and are connected in series—an arrangement which enables the pump to operate directly from atmospheric pressure down to pressures of the order of 1/1000 mm. mercury. The pump, which is American in origin, is small in size and readily portable. It is relatively silent in working, a feature appreciated by most workers with "box" pumps. The Hyvac pump, which marks, in our opinion, a real advance, is very suitable for furnishing a fore-vacuum for mercury vapour pumps. For its size it is rapid in action. Small discharge tubes can be exhausted in a few minutes, while in a test we find that so large a volume as 16 litres can be reduced from atmospheric pressure to 1/10 mm. in 30 minutes. The usual precautions must be taken. The oil must not be contaminated by water or organic vapours, or the performance will suffer. The gland about the main shaft may need very occasional attention, and the small leather non-return valve in the outlet of the first-stage unit should be renewed from time to time if the efficiency is to be maintained and if excessive leaking back of oil into the trap provided is to be avoided. If the driving belt from the motor (which is of slow speed and preferably English) is not kept tight, slipping may occur when starting up against atmospheric pressure.

BLUE ADSORPTION COMPOUNDS OF IODINE.—G. Barger and F. J. Eaton have carried the research on the blue adsorption compounds of iodine a stage further in a paper published in the Jour. Chem. Soc. for November. The constitutive and ionic influences on the formation of the various blue addition compounds with iodine are discussed. Substances having crossed conjugated double bonds (*e.g.* γ-pyrones) offer some of the best examples of the reaction; but it is now shown that many derivatives of 1 : 3 diketohydrindene do not react with iodine. The presence of a crossed conjugated double bond is not enough to ensure adsorption of iodine. The same remark applies to the bridge oxygen atom. The effect of hydrogen ion concentration on the adsorption is investigated by carrying out the adsorption in a phosphoric acid buffer solution. Wide variations in concentration of the phosphate ion affect neither the rapidity of formation of the blue complex nor its intensity. The main factor influencing the adsorption is probably molecular weight; it is probably not a constitutive factor, because compounds of the most diverse constitution are capable of giving a blue adsorption complex with iodine.

Cytology and Evolution.[1]

IT is now generally accepted as a fact that in cellular animals the control of their living activities, including the repetition of parental characters, resides in that specially highly evolved protoplasm known as chromatin. It has also been for many years realised that the behaviour of the chromosomes in mitosis—particularly their accurate longitudinal division—points to the linear arrangement of the different kinds of hereditary substance along the length of the chromosome. That this theoretical conclusion was accurate has been demonstrated beyond question by Morgan and his school. It has further been demonstrated that meiosis—the halving of the number of chromosomes in the gamete—is typically brought about by parasyndesis, the coming together of the homologous chromosomes in pairs. It is also the case that the two homologous chromosomes as they come together are similarly orientated: they are never "heads and tails."

These facts appear to justify certain important general conclusions.

(1) There exists an attractive force of a specific kind between particles of chromatin in the living cell. This is indicated (*a*) by the concentration of chromatin into chromosomes, and (*b*) by the approach of the chromosomes to one another in syndesis.

(2) The intensity of this attraction can be caused to vary by conditioning factors (*a*) of an extrinsic kind, as shown by the influence of radium on the gonad nuclei of Ascaris, and (*b*) of an intrinsic kind in the life of the cell; for example, the intensity increases during the prophases (shortening of chromosomes) and dies away in later phases of mitosis so as to be overborne in the case of the daughter chromosomes by the counter-attraction towards the centrosomes. This diminution in intensity is particularly marked in such a case as the somatic nuclei of early stages in the development of *Ascaris megalocephala*, where the chromosome loses its cohesion to the extent of fragmenting into numerous small particles.

(3) The intensity of attraction varies with the degree of likeness of the chromatin particles. This is indicated (*a*) by the localised clumping of chromatin at particular spots in the length of the chromosome ("chromomeres"), (*b*) by the coming together of *homologous* chromosomes in syndesis, and (*c*) by the fact that in parasyndesis corresponding portions of the two chromosomes come together.

[1] Abstract of an address delivered by Prof. J. Graham Kerr as retiring president of the Royal Philosophical Society of Glasgow (Biological Section), on October 10, 1924.

Natural Selection.

The view is taken that variability is to be regarded merely as a special case of the instability that is an inherent characteristic of all living substance, and therefore that it does not in itself call for special explanation. The idea that the hereditary substance (genes) is exempt from this general property, and stable and unvarying, is regarded as inherently improbable. Nature selects not variations of organs or other parts but whole individuals, according to their degree of "fitness" to their environmental conditions. As every individual is on one side or other of the normal line, the whole species is in direct touch with natural selection, not merely occasional individuals possessing some conspicuous abnormality of a particular organ, and there is therefore ample material for selection to work upon. It must not be forgotten that the selection of individuals showing a particular variation in detail necessarily involves the selection and consequent exaggeration of the *tendency* to develop that particular variation. This selection and intensification of tendency to vary in a particular direction has probably great directive influence in securing the continuity of evolutionary progress along definite lines.

The criticism that natural selection accounts only for adaptive features is now of greatly diminished importance. Certain features are known now to exist by mere chance; for example, the red colour of many deep-water marine animals. The advance of knowledge is constantly enlarging the number of features recognised as adaptive. Above all, it is now being realised far more fully how the various parts of the individual are shackled together by physiological relations through the internal medium of the body and in other ways, so that a small adaptive change in one organ is liable to carry with it correlated changes in other features of the body, possibly far more conspicuous and not in themselves adaptive.

Finally, it must be remembered that evolutionary adaptation to the environment has no natural term, for the elusive environment is in a state of continuous change in relation to the organism. Evolutionary change is a function (in the mathematical sense) of environmental change. Such change occurs in the environment itself—in the non-living environment—climatic or physiographical changes, or in the living environment—changes in the local fauna or flora; or, on the other hand, the active change may be on the part of the animal itself—such as change of habits from aquatic to terrestrial or aerial, from terrestrial to arboreal, from salt-water to fresh-water.

Progress in the Geological Survey of Great Britain.

THE Summary of Progress for 1923 of the Geological Survey of Great Britain and the Museum of Practical Geology[1] opens with the report of the Advisory Board. In this report we are reminded that in 1912 a Departmental Committee on the Science Museum and Geological Museum recommended the removal of the latter to a new building to be erected at South Kensington. The matter, shelved during the War, was not reopened until, in April 1923, the roof of the Geological Museum was found to be unsafe. It became necessary to close the Museum to the public, and later on to debar inquirers from access to the Survey offices, the Library, and the Map room. We now learn from the report that, on careful consideration of the position, the Government decided after the close of 1923 to erect a new museum and offices for the Geological Survey on the site recommended by the committee. Many will feel regret that a building and a situation with so many associations should be abandoned, but the advantages of the new site are manifest. The two great geological collections, one biologically arranged and illustrating stages in the evolution of life upon the globe, the other showing the forms of life which characterised each successive period in the history of the globe, will be side by side. It is to be expected also that adequate space will be provided not only for offices and workrooms, but also for the exhibition of minerals, rocks, and fossils now stored in drawers or overcrowded in exhibition

[1] Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1923; with Report of the Geological Survey Board and Report of the Director. Pp. iv+173. (London: H.M. Stationery Office, 1924.) 4s. net.

cases. An overcrowded case produces a mere sense of bewilderment, and to say that some of the cases in the Jermyn Street Museum contain twice as many specimens as they can properly exhibit, is no overstatement.

From the Director's report, we learn that nine field-units have been engaged in carrying out the programme approved for the year. In the London district, surveying proceeded in the Romford map and was commenced in the country near Marlborough. But the bulk of the summary relates to re-examination of coal-fields and their surroundings. In the Midland district, the various subdivisions of the Upper Coal Measures, including the Enville Group, have been recognised in the Coalbrookdale coal-field. The rocks examined range from pre-Cambrian to Trias. In the Yorkshire and Lancashire districts, advantage is being taken of the remapping of the Millstone Grit to examine the marine fauna, the Goniatites in particular, with the view of establishing a zonal sequence, the want of which has been much felt. The work in Lancashire has lain chiefly near Rochdale. In the Yorkshire district, the information respecting boreholes and new sinkings in the "concealed coal-field" is being kept up-to-date with the idea of preparing a new edition of the memoir on that important investigation. In Cumberland the sequence of limestones in the Lower Carboniferous Series has been established and work has been begun on the east side of the Vale of Eden. The correlation of the same limestones is being studied in Northumberland also, and the mapping of the Scremerston Series and of the Shilbottle Coal is well advanced. In Scotland, the Edge Coals of the Carboniferous Limestone Series are of scarcely less importance than those of the Coal Measures. Their examination is proceeding in Fife, the Lothians, Stirlingshire, Ayrshire, and Lanark.

Among the publications of 1923, special mention must be made of four parts of the great monograph on Carboniferous plants by the late Dr. Kidston, a work which will be of high value all the world over. The memoir on the Concealed Mesozoic Rocks of Kent is another notable contribution to palæontology, as well as to the stratigraphy of the south-east of England.

Two remarkable maps, issued, among others, during the same year, are of the highest interest to all geologists. One, of the Assynt district, is a special map made up of parts of the four one-inch sheets, 101, 102, 107, 108; the other, Sheet 44, illustrates Mull and its surroundings. To do justice to the geology without obscuring the topography was scarcely possible on so small a scale, but both maps are remarkable examples of detailed mapping and skilful mechanical reproduction.

The memoir which has been issued on the country around Flint, Hawarden, and Caergwrle[2] gives the results of a re-survey which commenced in 1910. The area described extends from the Vale of Clwyd to the peninsula of Wirral and includes the southern part of the Flintshire Coal Field. Probably in no other part of Great Britain do the Lower Carboniferous rocks show more remarkable changes than between north and south Flintshire. They have not been re-surveyed and the identity of the Millstone Grit is still in doubt, but it may be expected that the fossils, when opportunity occurs of collecting them, will throw light on the correlation, especially when taken in conjunction with the zonal work in progress in Yorkshire. The folding and faulting of the region are of high interest and complicated. A long dissertation upon them, not easy to follow, forms the subject of Chapter ii.

The district which Mr. Osborne White describes in the Memoir on the Country near Brighton and Worthing[3] has been rendered classic by the labours of Mantell, Martin, and Dixon. The formations range in age from Wealden to London Clay, and in his account of them, Mr. White has added many observations of his own to the work of previous workers. Chapter vii., dealing with the superficial deposits, is of much interest. It contains detailed accounts of the raised beach and the overlying Coombe Rock, each of which is made the subject of suggestive speculations. A word must be said for the plates. All are good, but Plate 1, in particular, gives an admirable representation of the features of a broad landscape.

[2] "Memoirs of the Geological Survey: England and Wales. Explanation of Sheet 108: The Geology of the Country around Flint, Hawarden, and Caergwrle." By C. B. Wedd and W. B. R. King; with Contributions by G. W. Lamplugh, Dr. H. H. Thomas, W. C. Simmons and T. C. Cantrill. Pp. viii+222+6 plates. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1924.) 6s. 6d. net.

[3] "Memoirs of the Geological Survey: England and Wales. Explanation of Sheets 318 and 333: The Geology of the Country near Brighton and Worthing." By H. J. Osborne White. Pp. vi+114+4 plates. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1924.) 9s. 5d. net.

Research in Optics.

THE volume referred to below[1] contains a number of papers first published during the years 1921 and 1922 by the staff of the Optics Division of the National Physical Laboratory. They have already appeared separately in the publications of various societies and elsewhere, to which reference must be made for the several discussions. A casual reader would be likely to comment upon the diversity of the subjects which are dealt with, but doubtless this is to be explained as the result of the numerous problems which arose during the War. In spite of this diversity, the volume embodies several theoretical papers of considerable value which have received notice in the newer editions of the well-known books of Southall, Czapski, and others. Amongst these may be instanced the discussion of the classification of optical instruments (No. xvii.).

The experimental side of the work is also well represented. It is instructive to notice how the "principle of substitution" can be applied in refractometry, goniometry, and curvature measurements, for the enhancement of the accuracy of measurements, and though in many cases the methods described are available for use only in a highly equipped laboratory where measurements of precision are required, yet such methods as that described in the paper on the photometry of optical instruments should find a place in the practice of every optical workshop.

A brief notice such as the present is not the place for detailed criticism of papers the majority of which have been already discussed. Nevertheless, there are papers which only seem to point the way to a very much fuller treatment of the subject. In a paper on the position of best focus in the presence of spherical aberration, it is stated to be erroneous to suppose that "geometrical reasoning leads in a number of important practical problems to conclusions at variance with those which would be deduced directly from a wave theory of light propagation." The paper goes on to show that in the presence of simple spherical aberration, the points of greatest

[1] "The National Physical Laboratory. Collected Researches." Vol. 17. 1922. Pp. v+353. (London: H.M. Stationery Office, 1922.) 17s. 6d. net.

axial intensity of light (deduced by the wave theory on the basis of least variation of phase, and by a corpuscular or ray theory on the basis of the centre of gravity of axial ray intersections) would agree as estimated by these two theories. The paper does not show, however, that the point of greatest axial intensity is necessarily taken as the best focus when visual or photographic observation is made, and indeed nothing but experiment can settle such a question. Further, the "best focus" in geometrical optics has been universally assumed to be coincident with the circle of least confusion, which is far from the point of greatest axial intensity when spherical aberration is present. In fact, the present writer's experience has been that the statement quoted above is by no means so erroneous as the author of the paper referred to believes. There are many such questions in optics which cannot be settled by a short mathematical or geometrical discussion, and the paper thus indicates the necessity of a very much wider inquiry.

There is no doubt that the writers of these papers will face many problems of difficulty in the immediate future. Much is to be hoped from a collaboration of mathematician and experimenter in investigations which need the services of both. The production and use of non-spherical glass surfaces on a commercial scale for instrumental work is very largely waiting accomplishment, and there are other "major researches" quite worthy of the efforts of any workers. The staff of the National Physical Laboratory has, however, unique opportunities of getting into touch with industry, and aid will doubtless be given where it is most required.

Terrestrial Magnetism in France.

THE work referred to below[1] contains in twelve pages summaries of seismological and meteorological results at Parc St. Maur from 1915 to 1922. The remainder of the volume is devoted to terrestrial magnetism. The longest single article is one by the late M. C. Dufour, discussing the magnetic records of 1922 at the Observatory of Val Joyeux, of which he was in charge. M. Dufour's death in August 1923 is recorded with regret. Hourly values at Val Joyeux are confined to 6 h., 12 h., 18 h., and 24 h., except on the international quiet days, when all hours are included. The daily mean from the whole 24 hours and the general character are given, however, for each day. From 1921 to 1922 westerly declination, inclination, horizontal force, and vertical force all fell by 11′·1, 0′·4, 9γ, and 31γ respectively.

Papers by MM. Berthelot, Mathias, and others record the progress of the magnetic survey being prosecuted at present in France. It is explained that adequate financial provision has as yet been made only for the field-work. Mme. de Madinhac, one of the lady members of Prof. Maurain's staff, contributes a paper giving the values of the magnetic elements on January 1, 1921, in the chief places of each department of France. These are based on Angot's results for 1911, and on values of secular change derived after Angot's example from twelve observatories of Western Europe, which include Eskdalemuir, Greenwich, and Kew. A second lady member of the staff, Mlle. Homery, arrives in a similar fashion at corresponding results for North Africa, and also deals in a separate paper with results from 422 stations in Western and French Equatorial Africa. Charts for the epoch January 1, 1921, are given in each of these three papers. Even in the case of France the secular change data available do not appear altogether above suspicion, especially in the case of horizontal force and dip. M. Rohan Chabot deals with magnetic observations made during 1912–13 in an expedition to Angola and Rhodesia.

Work of a more theoretical character is represented by a calculation of the vertical electric current derived from a line integral of magnetic force round an area including the greater part of France. The direction found for the current is upwards, but the amplitude, 0·0043 ampere per square kilometre, is of the same order apparently as the probable error.

An interesting paper by M. C. E. Brazier discusses the relations between magnetic disturbance at Parc St. Maur and Val Joyeux and sunspot activity. For disturbance, use is made of an arbitrary scale due to Moureaux. The period 1884 to 1917 is divided into three 11-year periods, which are dealt with as a whole and separately. As has been found in England, disturbance shows a well-marked annual period. The spring maximum, near the end of March, exceeds the autumn maximum, which occurs early in October. At the end of the volume there are reproductions of the most disturbed curves of the year at Val Joyeux.

C. CHREE.

[1] "Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau Central de Magnétisme terrestre," publiées par les soins de Ch. Maurain. Tome II. Quarto, pp. 146. Paris: Les Presses Universitaires de France, 1924.

Technical Education in Relation to Paper-making.

THE Board of Education has recently issued a report on technical education in England for the paper-making industry.[1] The report directs attention to the relatively small number of employees engaged in the manufacture of paper as compared with those of other trades such as engineering, textiles, iron and steel, but emphasises the point that the importance of the industry is probably enormously greater than the numbers employed would suggest, especially so where regard is paid to the uses of its products in commerce, education, and public administration.

Three points in the present development of the industry are important. These are:

(1) The development of the machines and other plant in use, so that the greater output is obtained at a less cost and a much increased speed. Up-to-date machinery is capable of producing paper such as "news," from a previously prepared pulp, in reels more than 200 in. wide, at a speed of more than 800 ft. per minute.

(2) Side by side there is a tendency towards larger mills and to the production of a particular paper for specific uses in any one mill.

(3) The gradual recognition of the aid which chemistry and engineering can render to the industry.

It would appear that the paper manufacturers of England are behind their American and continental competitors in their willingness to utilise the services of highly skilled specialists. The products of the English mills do not suffer in comparison with those of other countries, but if the future is to be secure, quality must be maintained and costs of production reduced. This can be accomplished only by attention to scientific methods and the systematic technical

[1] Board of Education: Report of H.M. Inspector on Technical Education in England for the Paper-making Industry. (London: H.M. Stationery Office, 1924.) 6d. net.

education of those engaged in the industry. The close co-operation of the engineer and chemist is essential. Encouragement is found in this direction in the formation of a technical section of the Paper-makers' Association, the aim of which is to foster the development of the industry along such lines.

Full-time courses of instruction in paper-making and allied subjects (chemistry, physics, etc.) are provided at the Manchester College of Technology. At the Battersea Polytechnic, London, such courses are also available, together with specialised instruction on the engineering side of the subject and on paper testing. Part-time courses (evening) are provided at these centres and at one or two other institutes.

The writer of the report has had the advantage of discussion with leading technologists connected with the industry, and makes recommendations concerning the further development of instruction by way of organised courses.

University and Educational Intelligence.

BIRMINGHAM.—The following doctorates have been awarded, the subjects of the theses being indicated in each case :—

D.Sc. (*Botany*), Mr. C. H. Gadd ("*Phytophthora Faberi*," and "The Swarming of Zoospores of *Phytophthora Faberi*," and other papers); (*Electrical Engineering*), Abdel Aziz Ahmed ("Theoretical and Experimental Study of the Electric Field in an Electrolytic Cell," "Variation of Magnetic Potential," "Investigation of Magnetic Leakage," and other papers). Ph.D. (*Biochemistry*), Mr. W. S. Shaw ("The Rôle of Silica and Phosphorus in Plant Growth and their Inter-Relations," and other papers); (*Civil Engineering*), Mr. H. V. Budgen ("Fatigue of Metals"); (*Electrical Engineering*), Mr. O. R. Randall ("The Behaviour of certain Semi-Conductors in Electric Circuits"); (*Metallurgy*), Mr. L. F. C. Northcott ("The Condition of Carbon in Iron").

CAMBRIDGE.—Mr. G. Stead, Clare College, has been appointed University lecturer in physics as applied to medical radiology. Dr. A. J. Copeland, Pembroke College, has been appointed assistant to the Downing professor of medicine. The Gordon Wigan Prize for research in chemistry has been awarded to E. H. Warren, Jesus College, for an investigation on "The Configuration of the Ammonium Ion."

It is of interest to note that of the eight successful candidates from the University in the last open competition for the Indian Civil Service, the top six studied mathematics or natural science in their Cambridge course.

EDINBURGH.—At the meeting of the University Court on December 15, it was decided to proceed at once with a scheme for the extension of the Department of Surgery in connexion with the grants recently received from the Rockefeller Foundation for the development of clinical teaching and research.

Dr. A. H. Freeland Barbour has made a further donation whereby the income of the Freeland Barbour Fellowship, awarded in each alternate year to the graduate in medicine who has taken a high place in anatomy, physiology, and pathology, and is judged most capable of carrying out research in midwifery or in diseases of women, will be increased from 120*l.* to 260*l.*

Approval by His Majesty in Council of the Court's Ordinance No. 45 (Foundation of the Chair of Organisation of Industry and Commerce) was intimated. This increases the number of professorships in the University to 55.

MANCHESTER.—Dr. W. H. Wood, lecturer in anatomy and tutor to the Faculty of Medicine, has resigned in consequence of his appointment to the Derby chair of anatomy in the University of Liverpool. Mr. H. G. Jordan, lecturer in mechanical engineering in the Faculty of Technology, has also resigned. Mr. Jordan has been a member of the staff of the College of Technology for forty-two years, and associated with the Faculty of Technology since its inception in 1906.

Mr. John Orr, at present Secretary to the Kent Rural Community Council, has been appointed adviser in agricultural economics under the Ministry of Agriculture and Fisheries Advisory Scheme, with the status of senior lecturer in the Faculty of Commerce and Administration and in the Department of Economics.

DR. W. R. COODE ADAMS has been appointed an assistant lecturer and demonstrator to Faraday House Electrical Engineering College.

DR. J. REILLY, Assistant State Chemist to the Irish Free State, has been appointed professor of chemistry in University College, Cork (National University of Ireland), in succession to Prof. A. E. Dixon.

PROF. GERLACH of Frankfort has been invited to occupy the chair of physics at the University of Tübingen in succession to Prof. F. Paschen, who was recently appointed president of the Physikalisch Technische Reichsanstalt in Berlin.

THE chairs of mathematics and English in the University of Tasmania, Hobart, will be vacated at the end of 1925. Applications are invited for them. Particulars of the posts may be obtained from the Agent-General for Tasmania, Australia House, Strand, W.C.2. The completed forms of application must be received by the Agent-General by January 31 at latest.

A DESCRIPTIVE list of "Government publications useful to teachers" as source books has been published by the United States Bureau of Education as Bulletin, 1924, No. 23. Its object is to meet a growing demand among teachers for primary sources of information to supplement text-books. The demand is especially urgent where the "project" method of instruction has been adopted. The list (34 pages, price 10 cents) is a handy guide to the publications of general interest of the United States Government—"the greatest of modern publishers."

A PRELIMINARY programme has been issued of the thirteenth annual Conference of Educational Associations to be held at University College, Gower Street, London, W.C.1, on January 1-8, under the presidency of Prof. E. A. Gardner, vice-chancellor of the University of London. The presidential address, on "Examinations: their Use and Abuse," will be delivered on the first day of the conference. Among the lectures which have been arranged are the following: "The Biology of some Common Animals," by Mr. Julian S. Huxley, on January 2; "The Measurement of Stellar Distances," by the Astronomer-Royal, on January 3; "Geography and the League of Nations," by Prof. H. J. Fleure, on January 8; "The Evidence for the Existence of Environmental Influence on the Course of Heredity," by Prof. E. W. MacBride, on January 8. Railway vouchers for return tickets for the meeting for single fare and a third can be obtained from the secretaries of the affiliated associations. A publishers' exhibition will be open in the Memorial Hall on January 2-7. The honorary organising secretary and treasurer for the conference is Miss Busk, 14 Taviton Street, W.C.1.

Early Science at the Royal Society.

December 28, 1664. Dr. Pell, upon occasion given by Sir Robert Moray, mentioned that he had at his country-house in Essex a wooden hoop, made by his directions in the year 1645, of twenty inches broad, representing the ecliptic, and at Amsterdam by Mr. Bleau lined with as much of the paper of Mr. Bleau's largest globes, as comprehends all the fixed stars within 10 deg. of the ecliptic on either side, but with the constellations inverted, as they stand in the heavens; the use of this being not only to help young observators, but also for the genuine representation of the variety appearing in the motion of the planets. He mentioned that he was willing to leave it with the Society when they shall have a fit repository to keep such instruments in.

December 29, 1686. Mr. Hooke read a further continuation of his discourse about shells, wherein he considered the structure of the nautilus, tending to prove, that though it be true, that there is no animal known resembling in all points the lineaments of those lately produced by himself; yet that it is not a sufficient argument to evince, that there is not for ever any such animal *in rerum naturâ*.

December 30, 1663. It being moved that it might be considered to make a standard of cold, it was suggested by Mr. Rooke, that this might conveniently be done by observing the degree of cold, which freezes distilled water, and by marking thereupon the expansion of the liquor in the weather-glass.—The difference of eels being discoursed of, and Mr. Henshaw mentioning the experience which the keeper of the eel-boat upon the Thames had of this sort of fish, he was desired to make what inquiry he could of that person concerning their difference, food, etc. The operator was ordered to provide some eels, and to put them into several waters, as river water, conduit water, etc., to see in which of them they will thrive best.—The business of propagating cider-fruit being again spoken of, the lord Ashley commended the red-streak, and especially the red red-streak for yielding a very rich liquor of a long duration, and for being a constant bearer. Mr. Boyle moved that some of the red-streak cider might be distilled and the spirit of it compared with wine. The lord Ashley offered a bottle for the trial.

1675. There was read a letter to Mr. Oldenburg from Mr. Newton, in answer to what had been written to him by Mr. Oldenburg concerning the want of success of his experiment made with a glass rubbed.

December 31, 1668. Dr. Wren produced a vessel contrived by himself to cure smoaking chimneys, which he affirmed had proved very effectual by divers trials. It was delivered to Mr. Hooke.

January 2, 1666/7. Mr. Hooke brought in the formerly proposed bucket for fetching up earth or any other solid body from the bottom of the sea. It was ordered, that care should be taken so to fit it, that the springs might go off both together, and that easily and certainly, and when it meets with soft ground, as well as hard; as also to grate it over.

1667/8. Mr. Panton appearing before the council, and expressing his desire for their assistance in promoting his design to establish a royal academy for educating of young gentlemen in good manners, languages, arts and sciences, and generous exercises; the council upon deliberation returned this answer, that though they well approved of this design, and were very desirous to promote it, each for himself, yet as they were a body, it was not their practice to intermeddle with any business, but such as either arose from among themselves, or came to them by way of reference.

Societies and Academies.

LONDON.

Aristotelian Society, December 1.—J. A. **Smith**: Prof. Alexander's notion of "space-time." The notion of space-time is equated by Alexander with that of pure motion. The elucidation of motion is a prime requisite for science. Alexander's aim is to help us to apprehend it immediately. Our difficulty in doing so is because we are sensitive and not purely intuitive beings. To remedy this we must endeavour to remount the stream of experience to its sources and reach a state of pure intuition. Pure motion is the simple intuition we then attain. We apprehend it not by definition but by a refinement of sensible motions and of mathematical motion. It is for science the surest and best hypothesis capable more than any other offered basis of supporting its structures.

Linnean Society, December 4.—A. B. **Rendle**: *Rafflesia Arnoldi* R. Br. and *Brugmansia Lowii* Becc., specimens sent for the British Museum by Mr. Edward Jacobson of Fort de Kock, Sumatra. They came from a forest at 800-1200 metres, near the west coast of Sumatra. Both plants are parasitic on the roots of a vine (a species of Cissus), and, except for slender threads permeating the tissue of the host, consist merely of a large flower, which in the Rafflesia measured 18 in. across.—L. J. **Wills**: The morphology of the Carboniferous scorpion, Eobuthus Fritsch. The specimen described was found near Chirk, N. Wales. It agrees fairly closely with Mr. R. I. Pocock's description of *Eobuthus holti*. The chief interest lies in the detailed structure of the chitinous test, which has been largely extracted from the shale in which it lay. The microscopic structure of the pecten can be closely matched in recent scorpions, even to the sensory papillæ. No stigmata occur on the sternites, but a thin hairy skin lies above the lobes, which no doubt protected the respiratory apparatus.—Miss V. **Hay**: Young and adult stages of *Sophora tetraptera*. Juvenile leaf-forms persist during several years on the seedlings of *Sophora tetraptera* and var. *microphylla*, and var. *prostrata*. Thus there appears to be one species with three varieties, or there may be three closely related species existing side by side under identical conditions.—Miss Violet M. **Grubb**: The development and liberation of spermatia in some undescribed cases among the Red Algæ. In *Nitophyllum Hilliæ* Grev., each antheridium mother-cell puts up in succession three beak-like protuberances, enclosed in the gelatinous extended mother cell-wall. The contents escape when ripe through an apical slit as a single spermatium clothed in a delicate wall. A similar development is found in *Callithamnion brachiatum* Bornem., where the antheridia are borne in clusters on the terminal pinnæ; secondary and tertiary antheridia grow up within the empty sheaths of the primary ones.

Royal Meteorological Society, December 17.—C. E. P. **Brooks**: The problem of mild polar climates. If there were an ice-free polar ocean just warm enough to prevent freezing at the pole and with a temperature increasing southwards at a uniform rate, and if a small decrease of temperature occurred uniformly over this ocean, a small polar ice-cap would form. If the temperature continued to fall, the growth of the ice-cap would become more and more rapid, until a point was reached beyond which the ice-cap would continue to grow without any further fall of temperature. This "critical temperature" is only about $0°{\cdot}25a$ below the freezing-point; a fall of temperature

of $0°{\cdot}25a$ would give an ice-cap with a radius of one degree of latitude, a fall of $0°{\cdot}3a$ would give an ice-cap with a radius of about 25 degrees of latitude. The "akryogenous" temperature, which the present Arctic Ocean would take up in winter if sea-water did not freeze, is about $270°a$. Hence a rise of the akryogenous winter temperature by only four or five degrees would suffice to cause a mild climate in winter. The land and sea distribution during Middle Eocene and Upper Jurassic times would give akryogenous January temperatures in latitude 75° N. of $278°{\cdot}6a$ and $280°{\cdot}8a$ respectively. Since these are well above the freezing-point they represent also the real temperatures. There is therefore a meteorological basis for mild polar climates. The Arctic Ocean has become ice-free once, possibly twice, since the Quaternary Ice Age, the second occasion falling in historic times.—Sir Napier **Shaw**: Winds and temperature in a dry atmosphere. The convection of dry air upward and downward and the distribution of temperature and potential temperature contingent thereupon would give rise to a much warmer stratosphere than the earth possesses with its present moist atmosphere. The general circulation, however, would not be different in its general character from that which prevails at present.

EDINBURGH.

Royal Society, December 8.—D. A. **Fairweather**: The electrolysis of salts of alkyloxyacids. An attempt was made to ascend the series of dibasic hydroxyacids (*i.e.* tartronic, tartaric, mucic, etc.) by electrolysis of the potassium ethyl salts of their ethylated derivatives. The products of electrolysis were of quite a different nature from those obtained in the case of the normal dibasic acids, and consisted chiefly of aldehydes; little or no synthesis took place.—W. **West** and E. B. **Ludlam**: The ionisation of iodine vapour by ultra-violet light. Iodine vapour was found to be ionised by light in the Schumann region. Quantum relations indicate that the molecule, or the fluorescing molecule, or both, may be ionised.—W. O. **Kermack** and W. T. H. **Williamson**: The stability of suspensions. I. The rate of precipitation of kaolin suspensions by salts at varying hydrogen ion concentrations. Anomalous effects in the rates of sedimentation of kaolin suspensions are observed in the cases of sodium chloride, mono-calcium phosphate, and aluminium, ferric, and lanthanum chlorides.—W. O. **Kermack** and C. I. B. **Voge**: The action of salts with multivalent cations on colloidal solutions of gold and gum benzoin. The action of solutions of ferric chloride, aluminium chloride, or lanthanum chloride in changing the charge on negatively charged colloidal particles to a positive one has been investigated more particularly in relation to the hydrogen ion concentration of the solution. The effect appears to be related to the degree of hydrolysis of the salt.—P. **MacCallum** and W. O. **Kermack**: The influence of gelatin on the stability of a colloidal solution of cholesterol and on the charge on the particles. Investigations are described on the action of solutions of gelatin at varying hydrogen ion concentrations in altering the properties of a cholesterol solution and the charge on the particles.

DUBLIN.

Royal Dublin Society, November 25.—Miss S. D. **King**: Oogenesis in *Lithobius forficatus*. Yolk formation is from nucleolar extrusion, supplemented possibly by activity of the Golgi bodies. The mitochondria are at first diffuse, later becoming concentrated. After active multiplication, which produces curious spherical mitochondrial masses, they once more become scattered through the cytoplasm. The juxta-nuclear Golgi apparatus of the young oocyte breaks up and passes out through the cytoplasm as growth proceeds.

Royal Irish Academy, December 15.—J. J. **Drumm**, N. **O'Reilly**, and H. **Ryan**: The isomeric $\alpha\alpha$ and $\alpha\gamma$ compounds of 2 : 4 : 6 : 3′ : 4′-pentamethony diphenyl propane. A synthesis of each of the above compounds is described. 2 : 4 : 6 : 3′ : 4′-Pentamethony-$\alpha\gamma$-diphenyl propane has been found to consist of colourless needles melting at 87-88° C., and to be identical with v. Kostanecki and Lampe's methylated reduction product of catechin tetramethyl ether. The above work, therefore, is in agreement with that of K. Freudenberg.

MANCHESTER.

Literary and Philosophical Society, December 16.—W. W. Haldane **Gee**: Joule's laws of electric heating. Considerable assistance was obtained in describing the early researches by the records contained in two Laboratory Notebooks in which Joule has noted his experiments. The first record relating to electric heating is dated "later end of August 1840." By October 3 in the same year Joule had completed a series of tests which enabled him to state that the heat produced by an electric current in a wire is directly proportional to its resistance, the square of the current strength and the time of its flow. He next proceeded to show that these laws applied to electrolytes. An important result of the thermo-chemical and electro-chemical determinations was a wide generalisation connecting chemical and electrical energies. A fact of historical interest in connexion with his laborious measurements was the early adoption of a unit of current strength and a unit of electrical resistance. Joule utilised his laws in an electrical method for finding specific heats. Details of his determinations are to be found in the later of the two Laboratory Books. This volume has also many records of the more accurate experiments relating to the laws of electric heating, which he submitted in a paper to the French Academy of Sciences. His calorimetric measurements were carried out to a still higher degree of perfection when in 1867 Joule showed that the value of the British Association ohm was not in agreement with his determination of the mechanical equivalent of heat. Amongst the practical outcomes of the experiments on electric heating is the process of electric welding, which Joule described in a paper in 1856 to the Manchester Literary and Philosophical Society.—J. Wilfrid **Jackson**: The occurrence of Conularia in the Carboniferous limestone of North Wales. *Conularia tenuis* was discovered in the basal beds of the Lower Brown Limestone near Dyserth. Hitherto the species has only been recorded from the Calciferous Sandstone Series at Glencartholm and Water of Leith, Edinburgh. The Dyserth Beds have been correlated with the top of the Seminula-Zone of the S.W. Province, but may be lower. They contain *Archæosigillaria vanuxemi*, which has been found in the Calciferous Sandstone Series in Scotland and at the base of the Viséan in Westmorland. The Calciferous Sandstone Series was correlated by the late Dr. R. Kidston with the Mountain Limestone of England, the overlying Carboniferous Limestone Series of Scotland being regarded as equivalent to the Yoredales of England. Dr. Kidston correlated a much higher plant-bearing horizon in N. Wales with the Calciferous Sandstone Series, namely, the Teilia Beds at the base of the Black Limestone and at least 1500 feet above the Dyserth Beds.

SHEFFIELD.

Society of Glass Technology, November 19.—Francis **Buckley**: Note on the glass-houses of the Leeds district in the seventeenth, eighteenth, and early nineteenth centuries. John Houghton, writing in 1691, stated that there were then three glass-houses in Yorkshire, one near Ferrybridge and two near Silkstone. The only glass-house actually in or near the town of Leeds in the eighteenth century was known as the Engine Glass-house, which can be traced between 1738 and 1770. The Engine Glass-house might have been the parent as well as the predecessor of the famous Hunslet Glass Works. Between 1814 and 1861, at any rate, the Bower family had several factories here. Leeds must have owed as much to this family in the nineteenth century as it did to the Fennys in the previous century. In 1883 they had four glass-houses at work, and no competition in the town itself. Just before 1850, however, there was a sudden increase in the glass concerns in Leeds and the surrounding district, especially in the neighbourhood of Castleford. An early nineteenth century glass-house at Thornhill Lees can be traced back to 1830. Here Noah Turner made flint glass until the glass-house was taken over by the Kilners in 1844, and converted into a bottle works. There was a glass-house also at Worsborough Dale prior to 1830, worked by William Usherwood, and in the year 1828 Messrs. Wood and Perkes were found in possession, making cut glass.—W. E. S. **Turner**: A striking instance of fireclay corrosion through the action of saltcake. During the emptying of a glass tank, with the gas flame still running, the fireclay blocks surrounding the dog-hole in a bottle-glass furnace began to swell and to flow soon after they became exposed to the action of the flame. When the tank was started, a charge of saltcake had probably been put into the dog-hole, under the belief that the blocking of the hole would be prevented. After examination it was found that the exposed portion of the blocks had absorbed saltcake at an early stage in the operation of the furnace, and being covered with glass and the dissociation temperature very high, the saltcake had remained unattacked, until contact with the flame during the emptying of the tank brought about decomposition.—H. S. **Houldsworth**: A note on some properties of a sandstone block after use in a glass furnace. Powdered Penshaw stone interacts as readily with a soda-lime glass as does crushed fireclay brick. Penshaw stone develops a close compact structure when used in a glass furnace. This tends to hinder the penetration of glass into the stone, thus adding to the life of the refractory, and pointing to its successful use in furnace construction.—A. **Cousen** and W. E. S. **Turner**: The production of colourless glass in tank furnaces, with special reference to the use of selenium. Pt. IV. The influence of arsenious oxide. Arsenious oxide alone is a decoloriser of glass containing small amounts of iron oxide, whilst it also suppresses the brown colour developed by selenium. Selenium and cobalt may therefore be regarded as only secondary materials in the decolorising process. An attempt to replace arsenic by its equivalent of phosphorus in the form of calcium phosphate showed the latter substance to have little or no effect upon the brown selenium colour. Antimonious oxide used instead of arsenious oxide with selenium gave a deep bluish-green colour.

PARIS.

Academy of Sciences, November 17.—M. Guillaume Bigourdan in the chair.—The president announced the death of Sir Archibald Geikie, foreign associate, and Eugène Simon, correspondant for the Section of Anatomy and Zoology.—H. **Deslandres**: A property common to spectra of different origin and structure. Preponderating action of the helium nucleus.—Maurice **Hamy**: The evolution of stars and the solar diameter.—J. B. **Senderens**: General method for the preparation of ethers. Starting with propyl, butyl, isobutyl, isoamyl, and isopropyl alcohols, the proportions of sulphuric acid and alcohol have been worked out which give maximum yields of the corresponding ethers.—D. **Mordouhay-Boltovskoy**: The transcendence of c^e and of certain other numbers.—Jules **Drach**: The problem of Tchebychew and the deformation of surfaces.—René **Garnier**: Study of the general integral of a differential system of order $2n$ round its transcendental singularities.—Paul **Lévy**: A problem of the calculus of variations.—Ragnard **Frisch**: A problem in the calculus of probabilities (the problem of Simmons).—E. **Brylinski**: The carrying away of the ether and the aberration of stars. The question as to whether the ether in the neighbourhood of the earth is or is not carried along with the earth cannot be decided by observations on the aberration of stars.—F. **Guéry**: The electric current considered as a circulation of equal charges of opposite signs. The theory of Weber is the only one at the present time in agreement with Maxwell's theory and with the hypothesis of the current being due to charges in movement in conductors.—Louis **de Broglie**: The dynamics of the light quantum and interferences.—Alb. **Colson**: The conditions of maximum solubility; the case of gypsum.—J. **Heyrovsky**: Electrolysis with the mercury drop cathode.—René **Audubert**: The photoelectric properties of the silver haloids and the mechanism of the formation of the latent image in photography.—P. **Freundler** and Mlle. Y. **Laurent**: The photochemical properties of stannous iodide.—Jean **Thibaud**: The γ-radiation of very great energy in active substances of the thorium group.—P. **Billon**: The primary β-amino-alcohols corresponding with the general formula $R.(NH_2).CH.CR_1R_2(CH_2.OH)$. The oxime of ethyl diethylacetoacetate was reduced by sodium and alcohol to the amino-alcohol, $CH_3.CH(NH_2).C(C_2H_5)_2.CH_2.OH$. The method would appear to be general.—J. **Orcel**: The determination of temperatures at which water is separated from silicates. The silicate is heated in an evacuated quartz tube by an electric furnace, and the pressure variations plotted as a function of the temperature. An example is given of the curve obtained with a sample of ripidolite (Madagascar), showing a sudden evolution of water vapour at 500°-510° C.—P. **Lebeau** and M. **Picon**: The transformation of the diamond at a high temperature *in vacuo*. In a vacuum a diamond may be exposed to a temperature of 1000° C. for twenty-four hours without change. At higher temperatures a partial change into graphite is observed. After thirty minutes' exposure to 2000° C., 10 per cent. still remained unchanged.—Jean **Jung**: The silicate enclosures of the cipolin of Saint-Philippe (Vosges, Alsace).—Jacques **de Lapparent**: The nature of the globigerina deposits in the layers between the Cretaceous and Eocene in the western Pyrenees.—Léon **Moret**: New observations on the exotic massifs of Sulens and Les Annes (Haute-Savoie).—E. **Huguenard**, A. **Magnan**, and A. **Plantol**: The variation of wind velocity with altitude near the ground.—E. **Rothé** and C. **Bois**: The earthquakes of July 10 and November 19, 1923, in the Pyrenees.—V. **Lubimenko**: The quantity of chlorophyll in the marine algæ.—L. **Plantefol**: The ecological problem for *Hypnum triquetrum*.—Armand **Dehorne**: Observa-

tion on the cells containing refractive bodies of Enchytræus (Oligochætæ). Resemblances to myelinic formations.—L. **Bounoure**: Origin of the primary gonocytes in the Triton and the signification of these elements in amphibians in general.—Denis **Bach**: The toxicity and food value of ammonium acetate for the lower fungi.— — **Pezard, Sand,** and **Caridroit**: Experimental bipartite gynandromorphism in the domestic cock. Racial recurrences governed by the autumnal moulting and the transitory character of certain pigmentary modifications.—Marc **Treillard**: The raising of *Daphnia magna* in a pure culture.—Robert **Lévy**: The mechanism of hæmolysis by scorpion poison. Comparison with other venoms.—Lucien **Cavel**: Contribution to the study of activated sludge. Very small quantities of free acid in sewage prevent nitrification and render inert the purifying properties of activated sludge.—G. **Leven**: Respiratory mechanism and treatment of serious symptoms of aerophagy.—G. **Sanarelli**: "Internal" anthrax in animals becoming carriers of anthrax spores.

SYDNEY

Linnean Society of New South Wales, October 29.—R. **Greig-Smith**: (1) The influence of certain colloids upon fermentation. Part i. Mineral colloids such as kieselguhr, kaolin, fuller's earth, silica, asbestos, as well as charcoal and agar-agar, acted as accelerating agents in hastening the fermentation of the slowly fermenting sugar, lactose, by the high temperature organism of fermenting tan-bark. Gelatinous ferric hydrate accelerated, while gelatinous aluminium hydrate retarded, the fermentation. As these are electro-positive and most other colloids are electro-negative, the electric charge had no influence under the conditions. Gelatine has no influence upon the fermentation of lactose or of itself. The precipitated phosphates of iron and alumina acted as accelerating colloids. (2) Note upon determining the hydrogen-ion concentration colorimetrically in small quantities of fluids. By using well-buffered solutions in fermentation experiments, small droplets (0·01 c.c.) may be abstracted and mixed with 0·5 c.c. of water held in the depression of a porcelain plate. On the addition of a drop of a suitable dye the active acidity can be determined, either by comparison with a drop of fluid of standardised hydrogen-ion concentration added to water in a neighbouring depression or by means of a series of coloured papers. With poorly buffered solutions dilution becomes impossible, but the plate with 0·5 c.c. of solution gives a fairly accurate picture of the acidity. Portions of agar slopes may be soaked in the 0·5 c.c. of water which soon becomes charged with the active ions and the colorimetric test can be made.—H. J. **Carter**: Australian Coleoptera. Notes and new species. No. iv. Two genera and 28 species are described as new.—G. H. **Hardy**: Australian Nemestrinidæ (Diptera). One species is described as new.

Royal Society of New South Wales, November 5.—R. H. **Cambage**: Landslides near Picton and notes on the local vegetation. The porous overlying sandstones in the locality become saturated after heavy rains and slip over the shales upon which they rest. The sandstone is calcareous, and certain trees, including the Kurrajong (*Brachychiton populneus*), seem to seek out portions of this particular sandstone formation largely because of the lime it contains. The Kurrajong avoids the more siliceous Hawkesbury Sandstone with lower lime content in the surrounding districts.

Official Publications Received.

Sixty-second Annual Report of the Government Cinchona Plantation and Factory in Bengal for the Year 1924. Pp. 9+xiv. (Calcutta: Bengal Secretariat Book Depot.) 7 annas.

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 15, Part 1: On a Japanese Salamander, in Lake Kuttarush, which propagates like the Axolotl. By Madoka Sasaki. Pp. 36+3 plates. (Sapporo.)

Department of Agriculture, Nairobi, Kenya Colony. Agriculture: Census of the Colony and Protectorate of Kenya for 1924. Fifth Annual Report, November 1924. Pp. 28. (Nairobi.)

Canada. Department of Mines: Mines Branch. Bentonite. By Hugh S. Spence. Pp. 36+13 plates. (Ottawa: F. A. Acland.)

Department of Agriculture: Tanganyika Territory. Report for the Fifteen Months ending March 31st, 1924. Pp. 36. (Dar-es-Salaam.) 2*s.* 6*d.*

University of Illinois Engineering Experiment Station. Bulletin No. 144: Power Studies in Illinois Coal Mining. By Prof. Arthur J. Hoskins and Prof. Thomas Fraser. Pp. 82. (Urbana.) Gratis.

Diary of Societies.

SATURDAY, DECEMBER 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (I.). Insect Collecting and what it leads to.

MONDAY, DECEMBER 29.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Major R. E. Cheesman: Wild Life of the Arabian Desert (Christmas Lectures for Young People).

ROYAL DUBLIN SOCIETY, at 4.—Lecture adapted to a Juvenile Auditory.

TUESDAY, DECEMBER 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (II.). The Habits of Bees and Wasps.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Section, Graduates' Meeting) (at Broadgate Café, Coventry).

WEDNESDAY, DECEMBER 31.

ROYAL DUBLIN SOCIETY, at 4.—Lecture adapted to a Juvenile Auditory.

THURSDAY, JANUARY 1.

GEOGRAPHICAL ASSOCIATION (Annual Meeting) (at London School of Economics), at 10.30 A.M.—Capt. M. W. Hilton Simpson and J. A. Haeseler: Life among the Ancient Hill Tribes of Algeria.—R. U. Sayce: Some Aspects of the Human Geography of Natal.—L. H. Dudley Buxton: The Historical Geography of Peking.—Miss K. de la Mare: Travels in the Western Mediterranean Region.—At 8.15 P.M.—Prof. J. L. Myres: Wayside Geography.—Prof. J. L. Myres and others: Discussion on Departmental Research Programmes.

CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at University College), at 2.30.—Prof. E. A. Gardner: Examinations: their Use and Abuse.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (III.). The Habits of Caterpillars.

FRIDAY, JANUARY 2.

GEOGRAPHICAL ASSOCIATION (Annual Meeting) (at London School of Economics), at 10.30 A.M.—Prof. J. L. Myres: A Geographical View of the Historical Method in Ethnology (Presidential Address).—R. Aitken: Geography and Spanish Problems.—Dr. A. Sommerfelt, H. Balfour, C. E. P. Brooks, C. B. Fawcett: A Symposium on the Life of the Fiord Peoples.

ASSOCIATION OF ASSISTANT MISTRESSES (at University College), at 2.30.—Dr. H. Crichton Miller: The Adult's Motive in Education.

SCHOOL NATURE STUDY UNION (at University College), at 3.—J. S. Huxley: The Biology of some Common Animals.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Dr. H. R. Mill: Some Explorers I knew (Christmas Lectures for Young People).

ROYAL DUBLIN SOCIETY, at 4.—Lecture adapted to a Juvenile Auditory.

BRITISH ASSOCIATION FOR PHYSICAL TRAINING (at University College), at 6.30.—Dr. H. Crichton Miller: Hygiene for Adolescents.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—J. McKissach: Some Pictorial Motives.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. Ringrose: Modern Flour-milling Machinery.

SATURDAY, JANUARY 3.

GEOGRAPHICAL ASSOCIATION (Annual Meeting) (at London School of Economics), at 9.30 A.M.—S. W. Rider and Capt. T. K. M. Booth: Discussion on School Geography.—Miss A. Hicks and others: Discussion on The Beginnings of Geography.—J. A. Mortlock, Miss J. A. Hardy, and others: Discussion on The Teaching of Climate.—Miss L. C. Read, C. C. Carter, and others: Discussion on Home Geography.—Mr. Cattell-Jones, Rev. J. I. Mille., and others: Discussion on School Geography Clubs and Journeys.

ASSOCIATION OF WOMEN SCIENCE TEACHERS (at University College), at 2.30.—Sir Frank Dyson: The Measurement of Stellar Distances.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Balfour Browne: Concerning the Habits of Insects (IV.). The Habits of the Dragonfly.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.), at 3.—Dr. W. Martin: Gilbert White as Antiquary.

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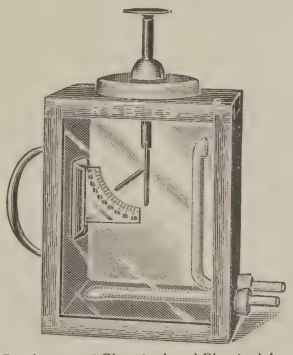

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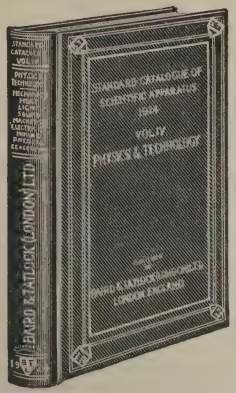

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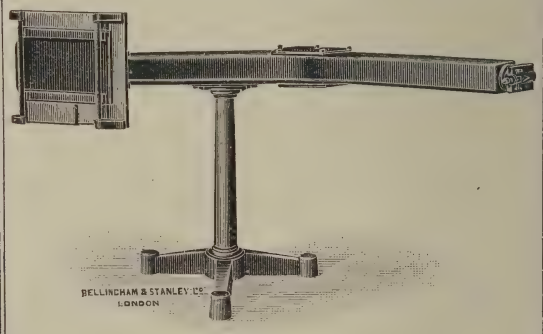

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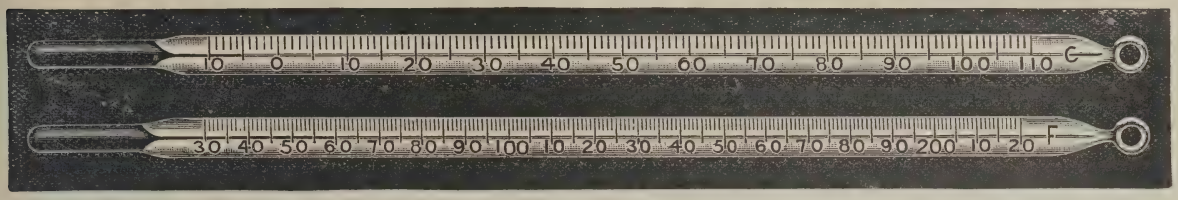

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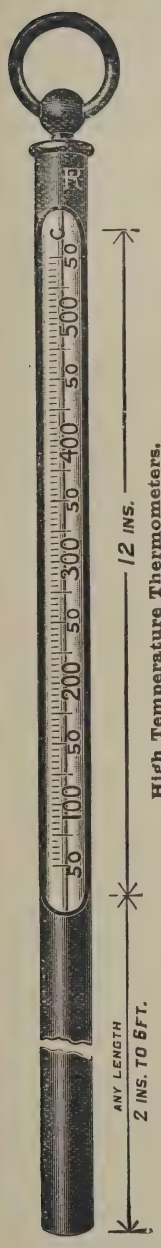

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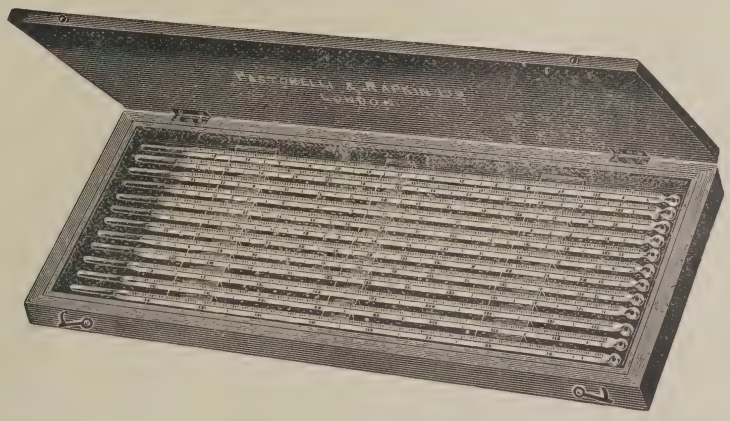

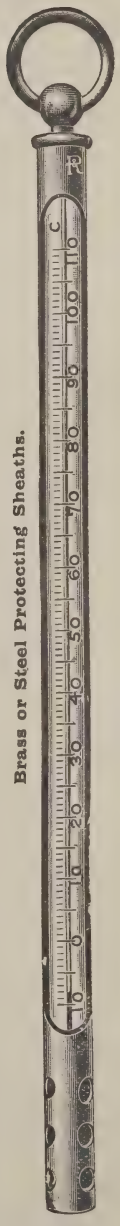

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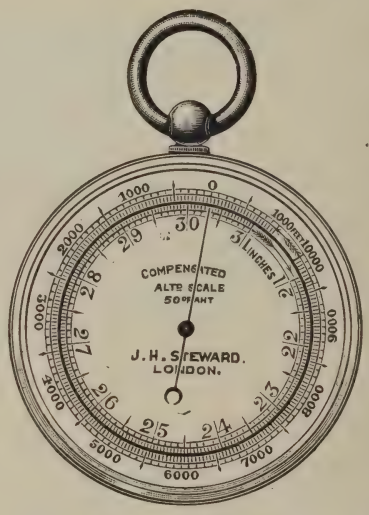

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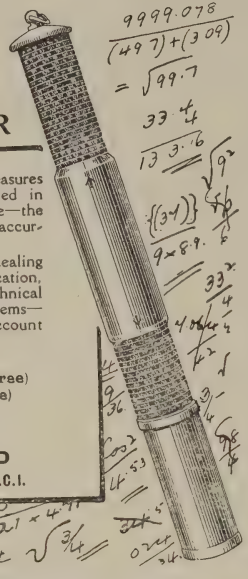

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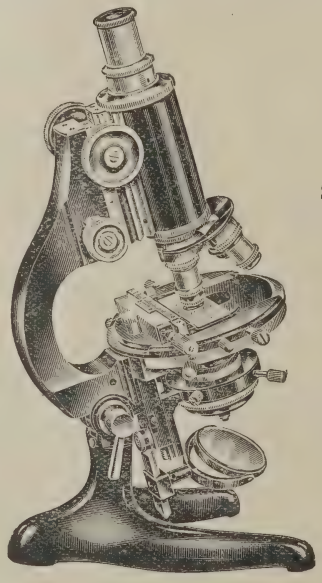

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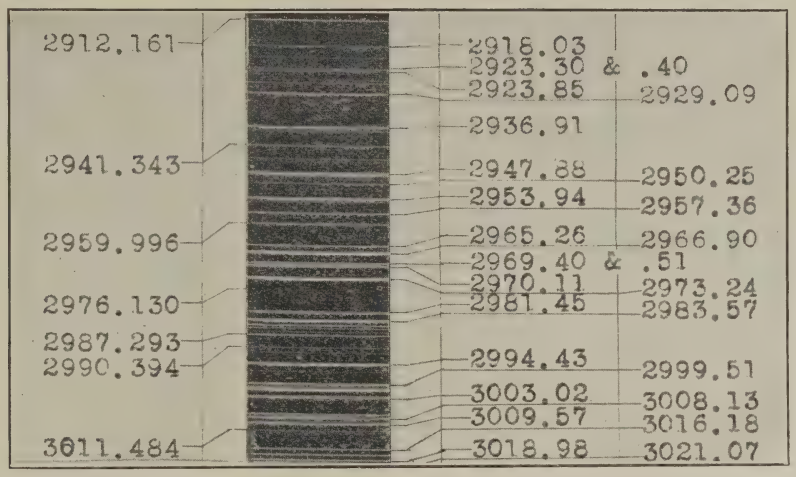

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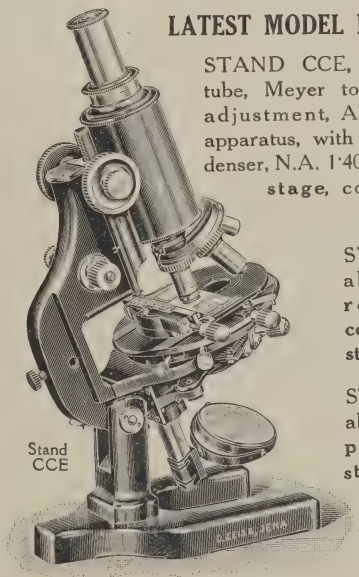

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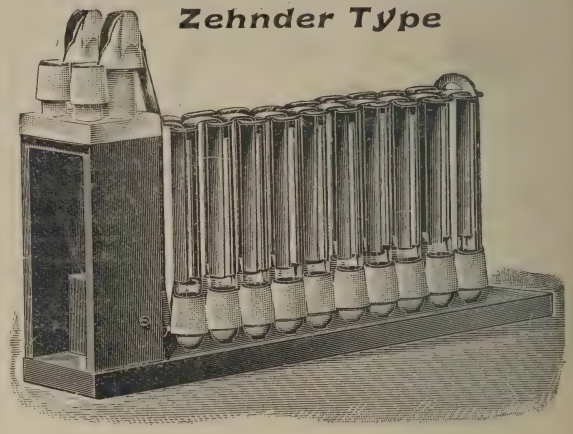

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